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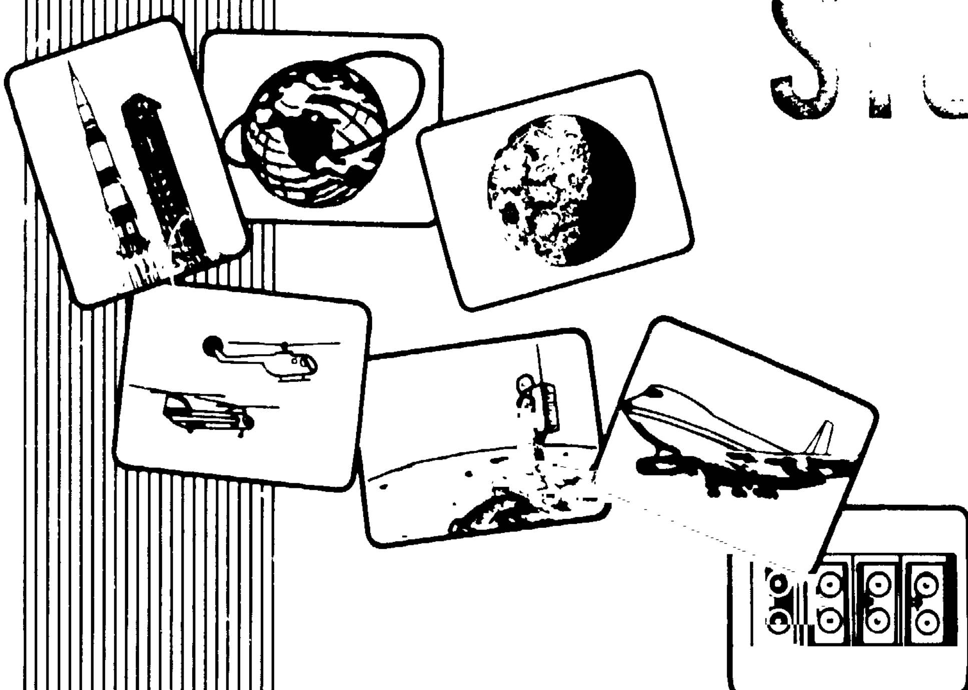
CREW APPLIANCE CONCEPTS

CREW APPLIANCE STUDY



THE BOEING COMPANY
HOUSTON, TEXAS

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Contract NAS 9-13965

July 18, 1975

Prepared by

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CREW APPLIANCE CONCEPTS

APPENDIX C

MODULAR SPACE STATION APPLIANCES SUPPORTING ENGINEERING DATA

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HABITABILITY SUBSYSTEM Housekeeping

APPLIANCE FUNCTIONS CONSIDERED

3.1.1 Surface Wiping
3.2.1 Manual Collection
3.2.2 Vacuum Collection
3.2.3 Refuse Transfer
3.2.4 Refuse Processing
3.2.5 Refuse Disposal
3.2.1 Washing
3.3.2 Drying
3.3.3 Washing/Drying Combination

DESCRIPTION The housekeeping habitability subsystem was designed to provide the cleanup, collection, processing, transfer and storage of refuse generated during a mission and crewman garment/linen maintenace. The study assumed refuse transfer would be accomplished manually for the missions under consideration. Longer term missions may eventually require some forms of automatic transfer. The housekeeping routines and equipment interface with all of the crew tasks, including experiments, medical research and care, system operations, dining, recreation, sleep, and personal hygiene.

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.1 Equipment Cleaning

APPLIANCE FUNCTION 3.1.1 Surface Wiping

NUMBER OF CONCEPTS CONSIDERED 12

ASSUMPTIONS

(1) Equipment cleaning includes all methods which use a moist wipe, cloth or sponge and a means of drying the item cleaned.
(2) The equipment cleaning function was assumed to be performed 15 times per day. Three times for meal cleanup, six times for cleanups of the personal hygiene area, three times for cleanup of spills, etc., and two for continency cleanup.
(3) Usage of a wetting unit, or equivalent, was based on 2.25 minutes per use.
(4) Washer/dryer penalty was based on washer concept 8, Water Spray Agitation and Dryer concept 1, Forced Hot Air - Electric Dryer.
(5) Water used for Space Station equipment cleaning was assumed to be recycled minus the water lost associated with the suspended solids. Shuttle water used is not recycled.

10001

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.1.1 **** SURFACE WIPING (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	15.000	2	.0003	.00	.0	21.1	105.	278.	500.0	360.0	192.0	5.47	2	30	156.3
	.037		(.0007)	(.00)	(.0)	(70.0)	(360.)	(948.)	.0	.0	(423.3)	(193.30)			(344.6)
		5	.2268	.00	1551.4	21.1									
			(.5000)	(.00)	(30.0)	(70.0)									
2	15.000	2	.0003	.00	.0	.0	105.	278.	500.0	360.0	96.8	.24	2	30	80.[illegible]
	.037		(.0007)	(.00)	(.0)	(.0)	(360.)	(948.)	.0	.0	(213.5)	(8.30)			(178.3)
		5	.2412	.00	1551.4	21.1									
			(.4200)	(.00)	(30.0)	(70.0)									
3	15.000						0.	0.	.0	.0	351.1	.72	1	10	351.2
	.037						(0.)	(0.)	.0	.0	(774.1)	(25.40)			(774.2)
4	15.000	5	.2268	.00	1551.4	21.1	791.	11.	52.8	31.5	10.5	.05	2	50	1.1
	.037		(.5000)	(.00)	(30.0)	(70.0)	(2700.)	(37.)	.0	.0	(23.0)	(1.70)			(2.4)
5	15.000	2	.0003	.00	.0	.0	105.	278.	500.0	361.0	100.6	.63	2	30	82.5
	.037		(.0007)	(.00)	(.0)	(.0)	(360.)	(948.)	.0	.0	(221.8)	(22.20)			(181.8)
		5	.2835	.00	1551.4	21.1									
			(.6250)	(.00)	(30.0)	(70.0)									
6	15.000	2	.0003	.00	.0	.0	32.	30.	57.5	57.5	62.5	1.00	1	5	46.9
	.037		(.0007)	(.00)	(.0)	(.0)	(110.)	(101.)	190.0	190.0	(137.8)	(35.40)			(103.3)
		5	.2381	.00	1810.0	51.7									
			(.5250)	(.00)	(35.0)	(125.0)									
7	15.000	2	.0003	.00	.0	21.1	105.	278.	500.0	360.0	129.5	5.45	2	30	82.1
	.037		(.0007)	(.00)	(.0)	(70.0)	(360.)	(948.)	.0	.0	(285.6)	(192.40)			(181.0)
		5	2.5402	.00	1551.4	51.7									
			(5.6000)	(.00)	(30.0)	(125.0)									
8	15.000	5	2.5946	.00	1551.4	51.7	105.	278.	500.0	360.0	33.3	[illegible]	2	30	6.6
	.037		(5.7200)	(.00)	(30.0)	(125.0)	(360.)	(948.)	.0	.0	(73.5)	(7.70)			(14.5)
9	15.000	5	2.6082	.00	1551.4	51.7	105.	278.	500.0	360.0	37.3	.30	2	30	8.3
	.037		(5.7500)	(.00)	(30.0)	(125.0)	(360.)	(948.)	.0	.0	(82.2)	(10.70)			(18.3)
10	15.000	5	2.5402	.00	1810.0	51.7	32.	146.	57.5	57.5	91.8	.99	1	5	65.3
	.037		(5.6000)	(.00)	(35.0)	(125.0)	(110.)	(499.)	190.0	190.0	(202.3)	(34.80)			(144.0)

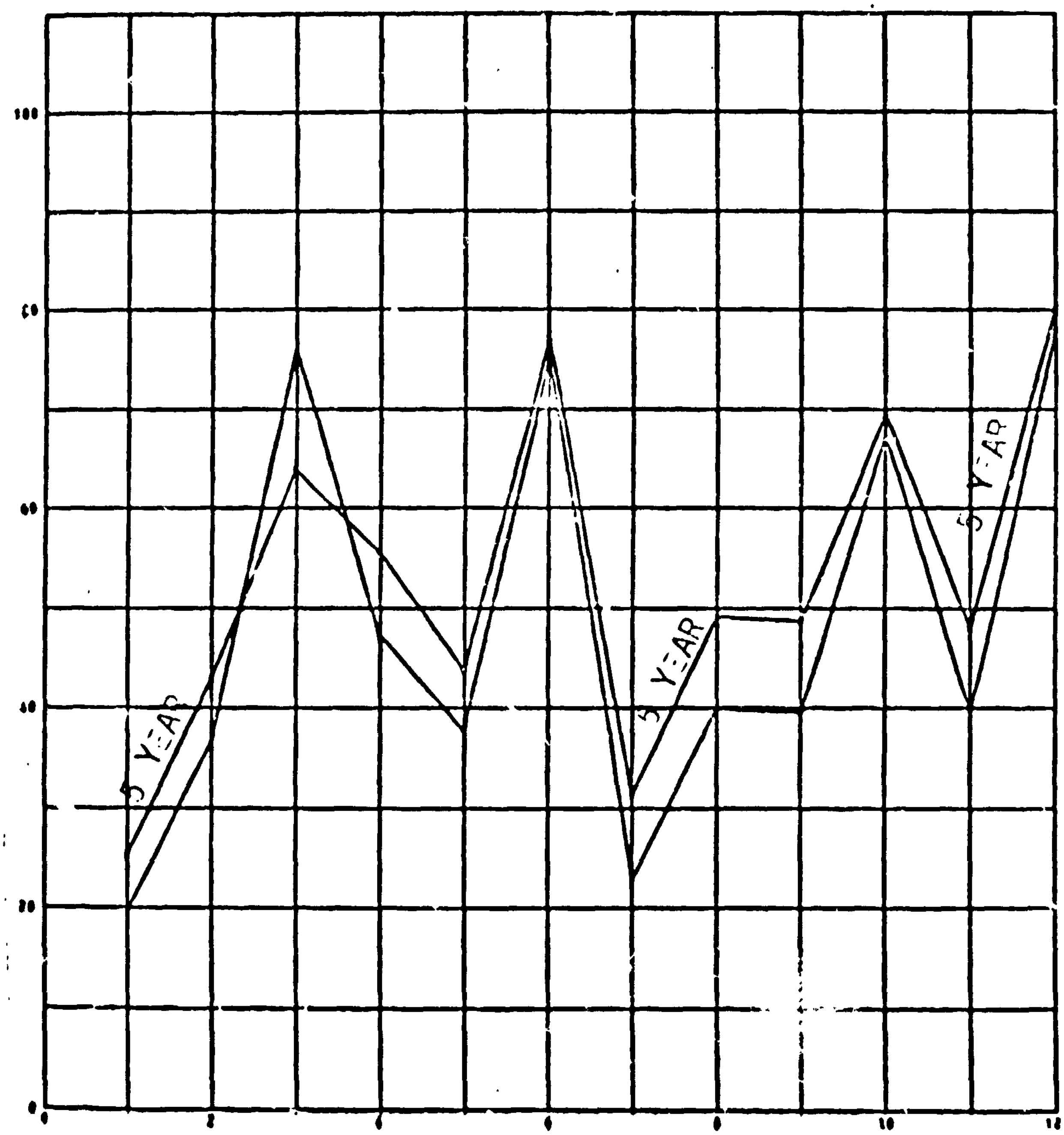
11	15.000	5	.2268	.00	1551.4	51.7	105.	278.	500.0	360.0	90.4	.13	2	30	27.5
	.037		(.5000)(	.00)	(30.0)	(125.0)	(360.)	(948.)	.0	.0	(89.1)	(9.40)			(60.6)
12	15.000	5	.2268	.00	1551.4	51.7	32.	30.	57.5	57.5	91.8	.06	1	5	27.5
	.037		(.5000)(	.00)	(30.0)	(125.0)	(110.)	(101.)	190.0	190.0	(92.1)	(2.20)			(60.6)

APPLIANCE CONCEPT NO.		CONCEPT NAME
1	-	DISPOSABLE WET/DRY WIPES
2	-	REUSABLE WET WIPES-DISPOSABLE DRY WIPES
3	-	DISPOSABLE WET/DRY WIPES (PREPACKAGED)
4	-	AUTOMATIC SPONGE MOP
5	-	REUSABLE CLEANING CLOTHS DISPOSABLE DRY WIPES
6	-	DISPOSABLE CLEANING CLOTHS (SKLAB) DISPOSABLE DRY WIPES
7	-	DISPOSABLE WET WIPES REUSABLE DRY WIPES
8	-	REUSABLE WET/DRY WIPES
9	-	REUSABLE CLEANING CLOTHS/DRY WIPES
10	-	DISPOSABLE CLEANING CLOTHS REUSABLE DRY WIDES
11	-	SPONGES/ENCLOSED WETTING UNIT
12	-	SPONGES/SKYLAB TYPE WETTING UNIT

(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST) , KG/HR (LB/HR)
3 - OXYGEN (LOST) , KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST) , KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED) , KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED) , KG/HR (LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

APPLIANCE CONCEPT NO.		CONCEPT NAME
1	-	DISPOSABLE WET/DRY WIPES
2	-	REUSABLE WET WIPES-DISPOSABLE DRY WIPES
3	-	DISPOSABLE WET/DRY WIPES (PREPACKAGED)
4	-	AUTOMATIC SPONGE MOP
5	-	REUSABLE CLEANING CLOTHS DISPOSABLE DRY WIPES
6	-	DISPOSABLE CLEANING CLOTHS (SKYLAB) DISPOSABLE DRY WIPES
7	-	DISPOSABLE WET WIPES REUSABLE DRY WIPES
8	-	REUSABLE WET/DRY WIPES
9	-	REUSABLE CLEANING CLOTHS/DRY WIPES
10	-	DISPOSABLE CLEANING CLOTHS REUSABLE DRY WIPES
11	-	SPONGES/ENCLOSED WETTING UNIT
12	-	SPONGES/SKYLAB TYPE WETTING UNIT



Surfacing Wiping (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 12
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • SURFACE WIPING (SPACE STATION)
(02/01/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
WEIGHT	23.042	774.10	15	6.80	10.86	.00	14.55	10.70	12.33	9.47	13.58	13.41	11.08	13.27	13.21
POWER	.00000	355.00	15	.00	.00	15.00	13.42	.00	9.78	.00	.00	.00	9.78	.00	9.78
VOLUME	1.7000	193.30	10	.00	9.57	8.69	9.91	8.85	8.17	.05	9.60	9.45	8.20	9.76	9.89
THERMAL	.00000	150.50	15	.97	.97	15.00	.00	.97	13.12	.97	.97	.97	8.05	.97	13.12
RELIAB-Y	.99745	1.0000	5	.51	.51	5.00	.00	1.65	1.48	.51	.51	.51	1.48	.51	1.48
MAINTENC	.99999	1.0000	5	1.33	1.33	5.00	.00	2.05	1.66	1.33	1.33	1.33	1.66	1.33	1.66
DEV COST	5.0000	50.000	15	6.00	6.00	12.00	.00	6.00	13.50	6.00	6.00	6.00	13.50	6.00	13.50
TOTAL PT	.00000	80.000	80	15.61	29.25	60.69	37.88	30.22	60.04	18.33	31.99	31.67	53.75	31.85	62.64
RATING	.00000	100.00	100	19.52	36.56	75.86	47.35	37.77	75.05	22.91	39.99	39.58	67.19	39.81	78.30

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	19.52	36.56	75.86	47.35	37.77	75.05	22.91	39.99	39.58	67.19	39.81	78.30
WEIGHT	21.73	39.63	69.36	51.61	40.65	75.66	26.35	41.32	43.85	67.76	43.98	79.14
POWER	17.84	33.43	77.93	50.96	34.53	74.21	20.94	36.56	36.19	67.02	36.40	77.18
VOLUME	18.37	40.04	76.50	50.40	40.76	75.44	21.59	43.28	42.81	68.06	43.21	79.51
THERMAL	18.40	33.98	77.93	43.29	35.09	76.12	21.50	37.11	36.75	66.03	36.95	79.09
RELIAB-Y	19.24	35.76	76.59	45.92	37.62	73.68	22.53	39.09	38.70	66.05	38.92	76.83
MAINTENC	19.73	36.26	76.59	45.92	37.87	73.78	23.02	39.58	39.19	66.16	39.41	76.94
DEV COST	21.27	36.85	76.21	43.29	37.96	76.33	24.37	39.99	39.62	69.14	39.83	79.31

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	19.52	36.56	75.86	47.35	37.77	75.05	22.91	39.99	39.58	67.19	39.81	78.30
WEIGHT	16.85	32.85	83.70	42.21	34.30	74.31	18.75	34.76	34.43	66.50	34.78	77.29
POWER	21.53	40.34	73.36	43.00	41.68	76.07	25.28	44.13	43.68	67.39	43.93	79.66
VOLUME	20.82	32.62	75.12	43.90	34.39	74.61	24.40	36.25	35.93	66.20	35.96	76.93
THERMAL	20.87	39.67	73.36	52.25	41.01	73.77	24.6.	43.46	43.01	68.59	43.26	77.36
RELIAB-Y	19.81	37.41	75.08	48.88	37.93	76.52	23.32	40.95	40.53	68.40	40.76	79.87
MAINTENC	19.29	36.88	75.08	48.88	37.67	76.40	22.79	40.42	40.00	68.28	40.24	79.76
DEV COST	17.40	36.20	75.43	52.25	37.54	73.51	21.14	39.99	39.54	64.83	39.79	77.09

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 12
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • SURFACE WIPING (SPACE STATION)
(02/01/75)

FACTOR	MIN VALUE	MAX VALUE	PTS.	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
WEIGHT.	23.042	774.10	15	6.80	10.86	.00	14.55	10.70	12.33	9.47	13.58	13.41	11.08	13.27	13.21
POWER	.00000	355.00	15	.00	.00	15.00	13.42	.00	9.78	.00	.00	.00	9.78	.00	9.78
VOLUME	1.7000	193.30	10	.00	9.57	8.69	9.91	8.85	8.17	.05	9.60	9.45	8.20	9.76	9.89
THERMAL	.00000	150.50	15	.97	.97	15.00	.00	.97	13.12	.97	.97	.97	8.05	.97	13.12
RELIAB-Y	.97442	1.0000	5	.51	.51	5.00	.00	1.63	1.47	.51	.51	.51	1.47	.51	1.47
MAINTENC	.99999	1.0000	5	1.33	1.33	5.00	.00	2.05	1.66	1.33	1.33	1.33	1.66	1.33	1.66
DEV COST	5.0000	50.000	15	6.00	6.00	12.00	.00	6.00	13.50	6.00	6.00	6.00	13.50	6.00	13.50
REC COST	2.4420	774.20	15	8.32	11.55	.00	14.95	11.48	13.00	11.49	14.72	14.65	12.21	13.82	13.82
TOTAL PT	.00000	95.000	95	23.93	40.79	60.69	52.83	41.68	73.03	29.81	46.70	46.31	65.95	45.67	76.46
RATING	.00000	100.00	100	25.19	42.94	63.88	55.61	43.88	76.87	31.38	49.16	48.75	69.42	48.07	80.48

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	25.19	42.94	63.88	55.61	43.88	76.87	31.38	49.16	48.75	69.42	48.07	80.48
WEIGHT	26.66	45.09	59.21	58.64	45.89	77.26	33.70	52.19	51.72	69.74	51.03	81.04
POWER	23.35	39.79	66.52	58.09	40.67	76.02	29.09	45.56	45.18	69.11	44.55	79.36
VOLUME	23.93	45.57	65.03	57.79	46.11	77.11	29.84	51.50	51.03	70.05	50.55	81.40
THERMAL	23.82	40.27	66.52	51.35	41.14	77.65	29.56	46.04	45.65	68.26	45.03	80.99
RELIAB-Y	24.80	42.10	64.81	54.19	43.59	75.65	30.84	48.16	47.76	68.39	47.10	79.17
MAINTENC	25.23	42.52	64.81	54.19	43.80	75.75	31.26	48.58	48.18	68.49	47.52	79.27
DEV COST	26.27	42.72	65.06	51.55	43.59	77.83	32.01	48.49	48.11	70.92	47.48	81.18
REC COST	27.41	45.43	59.21	58.84	46.26	77.59	34.69	52.74	52.32	70.29	51.30	81.34

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	25.19	42.94	63.88	55.61	43.88	76.87	31.38	49.16	48.75	69.42	48.07	80.48
WEIGHT	23.46	40.41	69.36	52.07	41.52	76.41	28.66	45.62	45.26	69.04	44.61	79.83
POWER	27.35	46.62	60.78	52.72	47.64	77.87	34.07	53.38	52.92	69.78	52.19	81.79
VOLUME	26.59	40.00	62.60	53.20	41.40	76.60	33.10	46.56	46.21	68.72	45.32	79.46
THERMAL	26.80	46.06	60.78	60.38	47.08	75.96	33.52	52.82	52.37	70.77	51.64	79.88
RELIAB-Y	25.60	43.82	62.90	57.12	44.18	78.15	31.96	50.22	49.79	70.50	49.10	81.86
MAINTENC	25.15	43.38	62.90	57.12	43.95	78.05	31.51	49.77	49.34	70.40	48.65	81.76
DEV COST	23.92	43.19	62.50	60.38	44.21	75.75	30.64	49.95	49.50	67.65	48.76	79.66
REC COST	22.59	40.02	69.36	51.84	41.08	76.03	27.51	44.97	44.55	68.39	44.29	79.48

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.1.1-EQUIPMENT CLEANING

APPLIANCE TYPE / COMPONENT TYPE	WATER SEPARATOR	FILTER	SOLENOID VALVE	HEAT EXCHANGER	ACCUMULATOR	TEMPERATURE CONTROL VALVE	CONTROLLER TIMER	CHECK VALVE	PUMP	MANUAL VALVE	HEATER	RELIEF VALVE	MOTOR	ELECTRIC SWITCH			NUMBER OF SAFETY CRITICAL ITEMS
NO.	6	9	3	16	4	24	19	22	2	23	17	25	1	10			
DISPOSABLE WET/DRY WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
REUSABLE WET WIPES/DISPOSABLE WET WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
DISPOSABLE WET/DRY WIPES	-	-	-	-	-	-	-	-	-	-	-	-	-	-			0
AUTOMATIC SPONGE MOP (ASTRO-VAC)	1	2	2	1	-	-	1	1	1	-	-	-	2	1			0
REUSABLE CLEANING CLOTHS/ DISPOSABLE DRY WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	-			0
DISPOSABLE CLEANING CLOTHS/ DISPOSABLE DRY WIPES	-	-	-	-	1	-	1	1	1	5	1	1	1	-			0
DISPOSABLE WET WIPES/REUSABLE DRY WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
REUSABLE WET WIPES/REUSABLE DRY WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
REUSABLE CLEANING CLOTHS/ REUSABLE DRY WIPES	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
DISPOSABLE CLEANING CLOTHS/ REUSABLE DRY WIPES	-	-	-	-	1	-	1	1	1	5	1	1	1	-			0
SPONGES/ENCLOSED WETTING UNIT	1	2	2	1	1	1	1	1	-	-	-	-	1	1			0
SPONGES/SKYLAB TYPE WETTING UNIT	-	-	-	-	1	-	1	1	1	5	1	1	1	-			0

SPACECRAFT Space Station

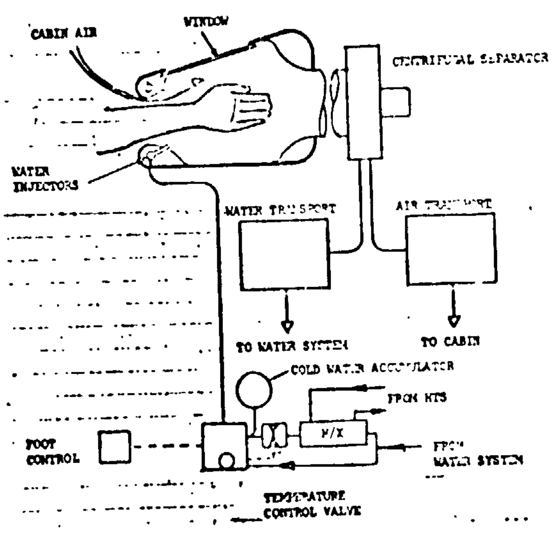
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

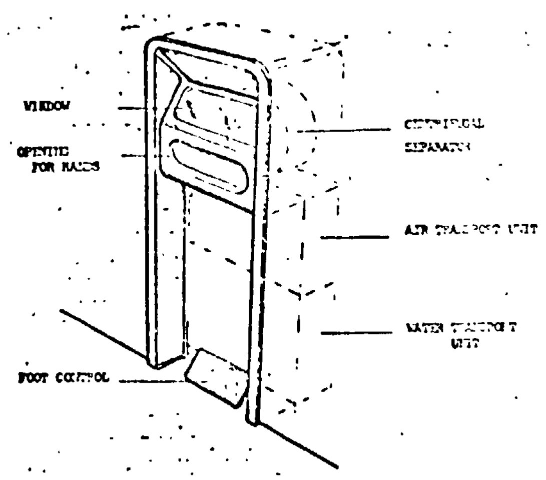
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 1/Disposable Wet/Dry Wipes

INDEX NO. 3.1.1.1 REF. NO. 236,186

DESCRIPTION The disposable wet/dry wipe concept utilizes a wet wipe for clean-up and dry wipe to soak up remaining moisture. A wetting unit with hand holes is supplied for the function. The wetting unit has a water supply outlet and a fan for providing water entrainment during use. A centrifugal separator is provided upstream of the blower to collect used water. Water temperature is controlled by mixing hot with cold water in a temperature controlled mixing valve. The crew-man wets the wipe, uses it for area cleanup (disinfectant soap is located at the wetting unit) and can be rewetted if necessary for cleanup. The wipe is wrung out in the wetting unit and disposed of by deposit into a vacuum drier to remove excess water. Dry wipe's are provided to dry damp areas left by the wet wipe. The used wipes are deposited into the refuse system. The disposable wipes are 12 inch squares of 4 ply "wet strength" paper. One wet wipe and one dry wipe are provided per cleanup based on a maximum of 15 cleanup functions per day.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 1/DISPOSABLE WET/DRY WIPES INDEX NUMBER 3.1.6.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTING UNIT (236)	.0375	500	360	13.5	—	—	—
		500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (949) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 1/DISPOSABLE WET/DRY WIPES — INDEX NUMBER 3.1.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
WETTING UNIT	(236)	76.69	185.0
WET/DRY WIPES	(236)	82.8	8.28
TOTAL		72.34 (159.5) KG (LBS)	5.47 (193.3) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
WET WIPES	1 (236)	.015 (236)	.015	.0015	.0015
DRY WIPES	1 (236)	.015 (236)	.015	.0015	.0015
			Σ③ .030 TOTAL WT/CYCLE (LB)		Σ⑤ .0030 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .030 TOT.WT/CYCLE (LB) = 37.56 (82.8) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0030 TOT.VOL/CYCLE (FT³) = .234 (8.28) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
OXYGEN (WIPE DISPOSAL)	.000719	N/A	N/A	.000719
WATER	.5	1-.0009	.4995	.0005
WATER LOSS (WET WIPE)	.0454	N/A	N/A	.0454
WATER LOSS (DRY WIPE)	.0490	N/A	N/A	.0490
	Σ① .5951			Σ④ .0956

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0956 TOTAL LOST/CYCLE (Σ④) + 263.8 (LB) + .5941 (Σ①) = 119.9 (264.4) KG (LB)

SPACECRAFT Space Station

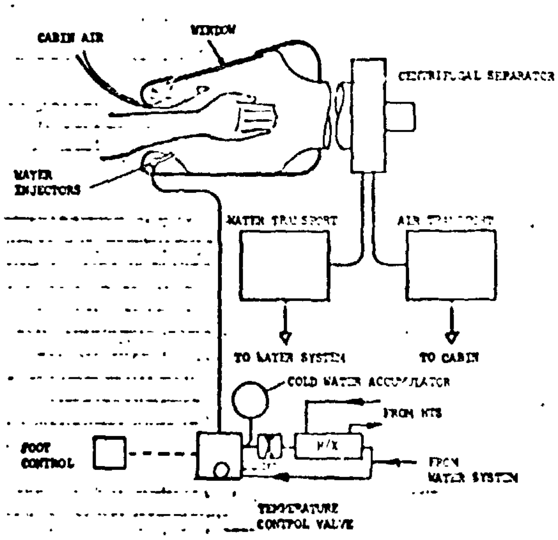
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

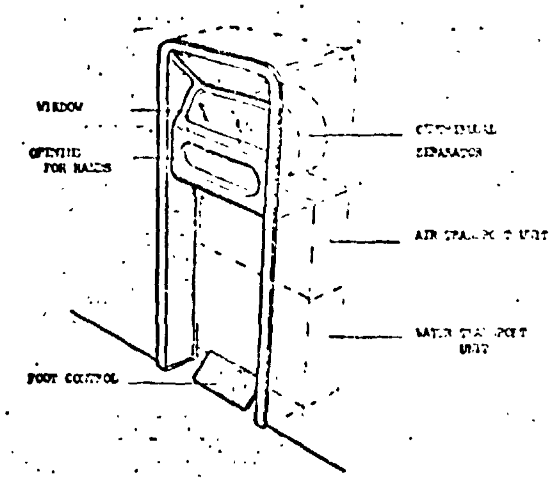
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 2/Reusable Wet/Disposable Dry Wipes

INDEX NO. 3.1.1.2 REF. NO. 236,186

DESCRIPTION The reusable wet/disposable dry wipe concept utilizes a wet reusable wipe for cleanup and a disposable dry wipe to soak up remaining moisture. The wetting unit described in concept 1 is also required for this concept. The reusable wipes, however, are wrung out in the wetting unit and reused. Three reusable wipes are provided for a maximum 15 cleanups per day. The wipe is used a maximum of 5 times before washing. After sixty washings, the wipe is discarded and replaced. The reusable wipes are 10 inches square of 4 ply "wet strength" paper. The disposable dry wipes are 12 inch squares of 4 ply "wet strength" paper. One dry wipe per cleanup are provisioned which are disposed of by deposit into a vacuum drier to remove excess water. The dry wipes are provided to dry damp areas left by the wet wipe.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/REUSABLE WET/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTING UNIT	(236)	.0375	500	360	13.5			
			500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
WASHER	82	—	3.9	3.27	.29
DRYER	5.8	11.1	4.9	1.31	.29
TOTAL	25.7 (87.8) WATTS/CYCLE (BTU/HR/CYCLE)	3.26 (11.1) WATTS/CYCLE (BTU/HR/CYCLE)	8.8	2.08 (4.58) KG/MISSION (LB/MISSION)	.0164 (.58) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/REUSABLE WET/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	28.49	3.5
WET/DISPOSABLE DRY WIPES	(236)	41.5	4.27
TOTAL		31.75 (69.99) KG (LBS)	.220 (7.77) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WET WIPES	.0167 (236)	.004 (236)	.0000668	.00252 (236)	.0000421
DISPOSABLE DRY WIPES	1 (236)	.015 (236)	.015	.0015	.0015

Σ③ .0150668 TOTAL WT/CYCLE (LB)

Σ⑤ .0015421 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0150668 TOT.WT/CYCLE (LB) = 18.86 (41.5) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0015421 TOT.VOL/CYCLE (FT^3) = .1205 (4.27) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5 (236)	1-.0009	.4995	.0005
WASHER WATER LOSS PENALTY	.12	1-.0009	.11989	.00011
WATER LOSS (DRY WIPE)	.0490	N/A	N/A	.0490
OXYGEN (WIPE DISPOSAL)	.000719	N/A	N/A	.000719

Σ① .6697 Σ④ .0503

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0503 TOTAL LOST/CYCLE (Σ④) = 138.9 (LB) + .6697 (Σ①) = 63.3 (139.6) KG (LB)

SPACECRAFT Space Station

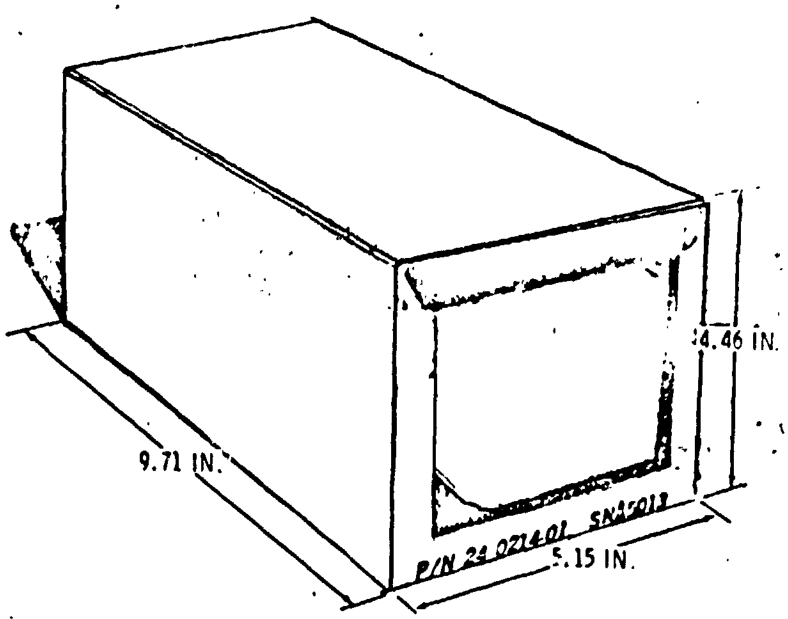
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 3/Disposable Wet/Dry Wipes (Prepackaged)

INDEX NO. 3.1.1.3 REF. NO. 250,283

DESCRIPTION The disposable wet/dry wipes concept consists of prepackaged wet wipes which were used on Skylab. The wet wipes are contained within a package to eliminate water evaporation during storage. The dry wipes are dispensed from a 196 count container. The wet and dry wipes are used for cleanup and discarded. The Skylab size wet wipe weight and volume were ratioed (6.3) to the 10 inch square wipes used in Concepts 1 and 2 in order to provide a equivalent trade.



Wipe Dispenser

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/DISPOSABLE WET/DRY WIPES (PREPACKAGED) INDEX NUMBER 3.1.1.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT	REF	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	(7) DEMAND (WATT-HR/CYCLE) (1)x(7)
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/DISPOSABLE WET/DRY WIPES (PREPACKAGED) INDEX NUMBER 3.1.1.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
WET/DRY WIPES	(236, 250)	774.2	25.39
TOTAL		351.1 (774.2) KG (LBS)	.718 (25.39) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
WET WIPES	.5 (236)	5.6/301 (6.3) (Nelox)	.1172	.161/301 (6.3) (Nelox)	.0027
BIOCIDE WIPES	.5 (236)	3.37/70 (6.3) (250)	.153	.729/75 (6.3) (250)	.0058
DRY WIPES	1 (236)	2.02/196 (250)	.0103	.129/196 (250)	.0007

Σ③ .2805 TOTAL WT/CYCLE (LB) Σ⑤ .0092 TOTAL VOL CYCLE (FT³)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .2805 TOT. WT/CYCLE (LB) = 351.2 (774.2) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0092 TOT. VOL/CYCLE (FT³) = .718 (25.39) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① Σ④

TOTAL WT. MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE = (LB) = KG (LB)
& ④ & ①

SPACECRAFT Space Station

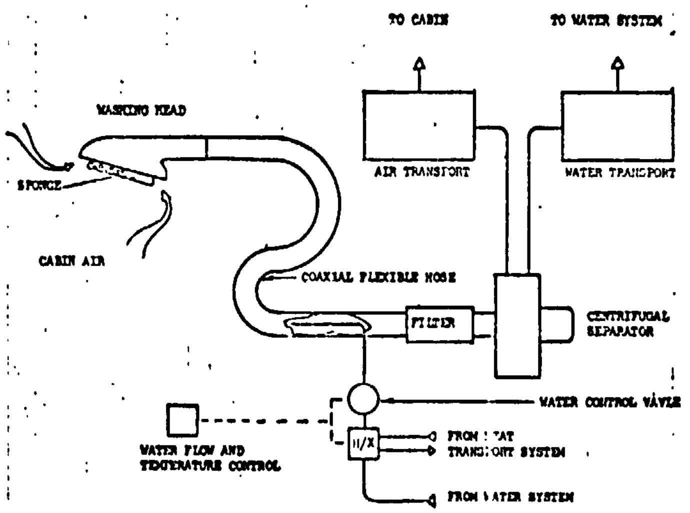
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

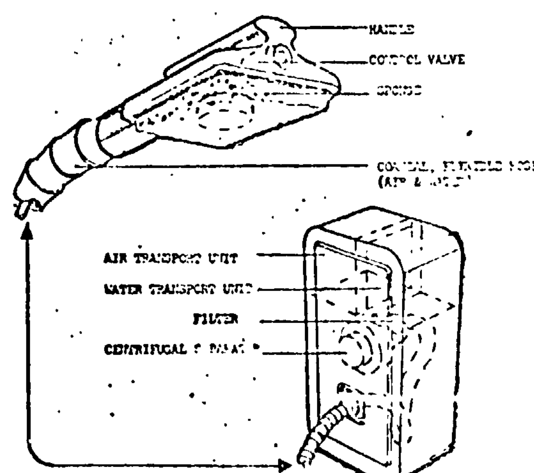
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 4/Automatic Mop

INDEX NO. 3.1.1.4 REF. NO. 236,100

DESCRIPTION The automatic mop concept is a hand held scrubber head connected by coaxial flex tubing to a water supply valve and an air transport system. Water is fed into a sponge in the scrubber head for use in cleaning equipment. A water pick up housing connected to the vacuum line surrounds the sponge. A water separator is used to collect water from the cabin air. A pump unit injects water into the water waste management system. One new sponge is provided per week.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 4/AUTOMATIC MOP

INDEX NUMBER 3.1.1.4

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
AUTOMATIC MOP UNIT (236)	.0375	52.8	31.7	1.19			
		52.8 MAXIMUM		1.19 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	2700	36.7	36.7	2700
MOTORS				
TOTAL	791 (2700) WATT (BTU/HR)	10.8 (36.7) WATT (BTU/HR)	10.8 (36.7) WATT (BTU/HR)	791 (2700) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 4/AUTOMATIC MOP — INDEX NUMBER 3.1.1.4

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
AUTOMATIC MOP UNIT (236)	20.6	1.5
SPONGES	1.18	.19
TOTAL	9.88 (21.78) KG (LBS)	.048 (1.7) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
SPONGES	.143 (236)	.002989 (236)	.000427	.000481 (236)	.000069

Σ③ .000427 TOTAL WT/CYCLE (LB)

Σ⑤ .000069 TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .000427 TOT.WT/CYCLE (LB) = .534 (1.18) KG (LB)

TOTAL VOL/MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .000069 TOT.VOL/CYCLE (FT^3) = .0054 (.19) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5 (236)	1-.0009	.49955	.00045

Σ① .5

Σ④ .00045

TOTAL WT./MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .00045 TOTAL LOST/CYCLE (Σ④) = 1.24 (LB) + .5 (Σ①) = .790 (1.74) KG (LB)

SPACECRAFT Space Station

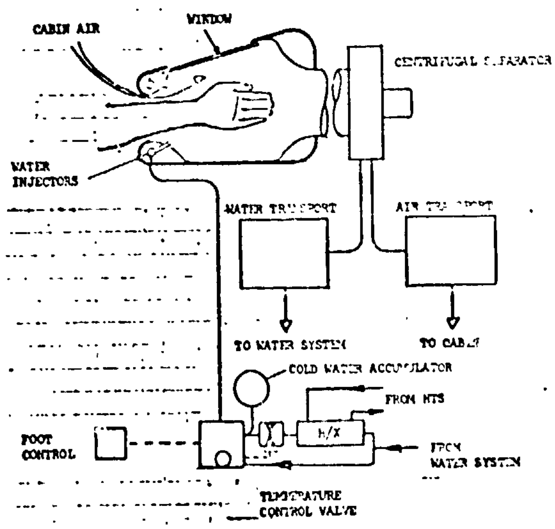
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

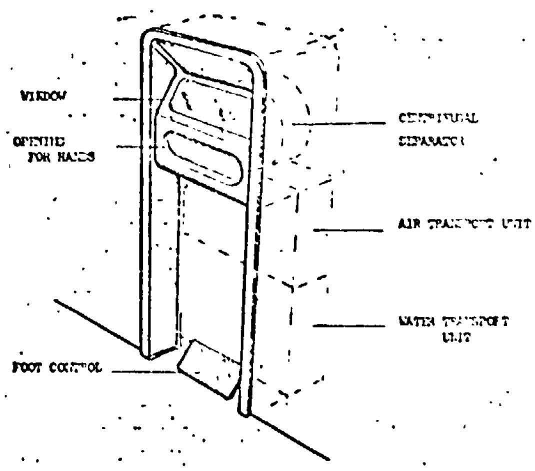
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 5/Reusable Cleaning Cloths/Disposable Dry Wipes

INDEX NO. 3.1.1.5 REF. NO. 236,237,245,209

DESCRIPTION The reusable cleaning cloth/disposable dry wipe concept is the same as Concept 2; however, terry cloth are used for cleansing cloths. The terry wash clothes are 6 inches square. The cleaning cloths are provisioned 3 per day for a maximum of 5 clean up functions. The cleaning cloth is used for sixty washings then is discarded and replaced. The cleaning cloth is washed and dried daily using a washing machine and dryer. The disposable dry wipes are 12 inch squares of 4 ply "wet strength" paper. Once disposable dry wipe is provided per clean up based on a maximum of 15 cleanup functions per day. The wipes are disposed of by deposit in the refuse system. The concept is penalized for theusage of a wash/dryer for recycling the terry cloth cleaning cloths.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 5/REUSABLE CLEANING CLOTHS/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.5

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTING UNIT (2.3.4)	.0375	500	361	13.5	—	—	—
		500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
WASHER	171	—	8.0	6.8	.61
DRYER	12.3	22.9	10.0	2.7	.60
TOTAL	53.7 (183.3) WATTS/CYCLE (BTU/HR/CYCLE)	6.7 (22.9) WATTS/CYCLE (BTU/HR/CYCLE)	18.0	4.3 (9.5) KG/MISSION (LB/MISSION)	.034 (1.21) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 5/REUSABLE CLEANING CLOTHS/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.5

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	28.49	3.5
CLEANING CLOTHS			
WIPES	(236)	44.99	6.65
TOTAL		33.3 (73.48) KG (LBS)	.287 (10.15) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
CLEANING CLOTHS	.0166 (236)	.077	.0013	.0546 (209)	.00091
DRY WIPES	1 (236)	.015 (236)	.015	.0015 (236)	.0015
			Σ③ .0163 TOTAL WT/CYCLE (LB)		Σ⑤ .00241 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0163 TOT.WT/CYCLE (LB) = 20.41 KG (LB) (44.99)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .00241 TOT.VOL/CYCLE (FT^3) = .188 M^3 (FT^3) (6.65)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5 (236)	1-.0009	.49955	.00045
WASHER WATER				
LOSS PENALTY	.125	1-.0009	.12489	.00011
WATER LOSS (DRY WIPES)	.049	N/A	N/A	.049
OXYGEN (WIPE DISPOSAL)	.000719	N/A	N/A	.000719
	Σ① .67472			Σ④ .0503

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0503 TOTAL LOST/CYCLE (Σ④) = 138.8 (LB) + .67472 (Σ①) = 63.3 (139.4) KG (LB)

SPACECRAFT Space Station

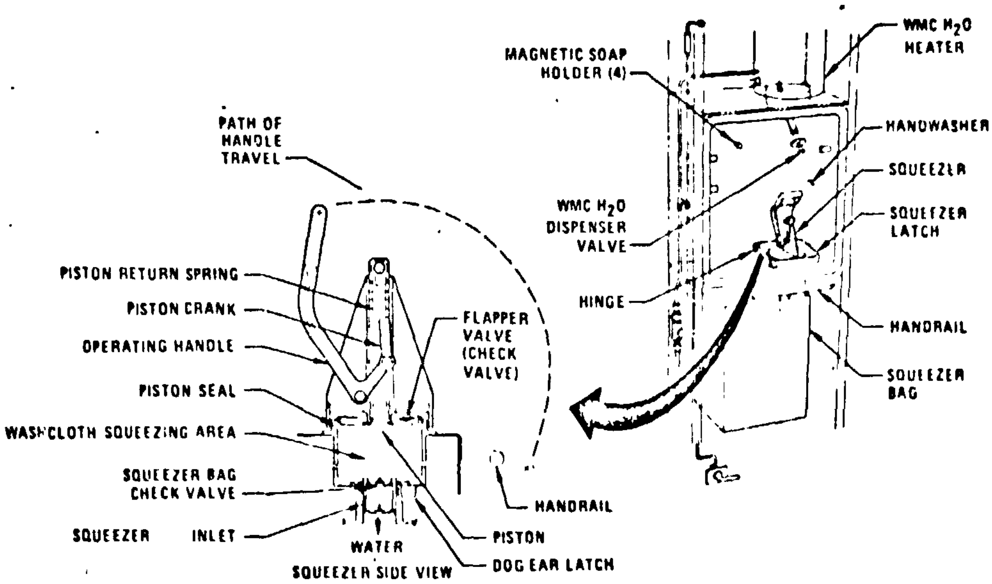
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

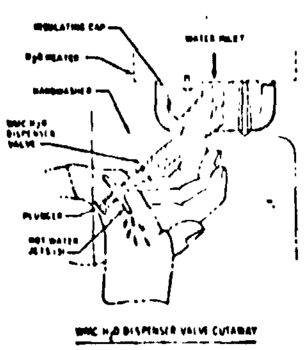
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 6/Disposable Cleaning Coths/Disposable Dry Wipes

INDEX NO. 3.1.1.6 REF. NO. 236,283

DESCRIPTION The disposable cleaning cloths/disposable dry wipes concept is the system used on the Skylab applied to equipment cleaning. The terry cloth cleaning cloths are wetted by depressing a water supply valve. The unit will provide warm water from a heated storage tank. After the cloth is used, it is squeezed using a manual squeezer unit. The water squeezed from the cleaning cloth is assumed to be recovered and routed to the water waste management system. Three cleaning cloths are provided per day for a maximum of 15 cleanup functions. The cleaning cloths are disposed of by deposit into a vacuum dryer to remove excess water. The dried cloth is then deposited into the refuse system. The disposable wipes are 12 inch squares of 4 ply "wet strength" paper. One dry wipe is provided per cleanup based on a maximum of 15 cleanup functions per day. The used dry wipe is deposited into the refuse system.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 6/DISPOSABLE CLEANING CLOTHS/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.6

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
HEATER (293)	.0375	—	—	—	140	140	5.25
WATER PUMP	.0375	57.5	57.5	2.15	—	—	—
		57.5 MAXIMUM		2.15 TOTAL	140 MAXIMUM		5.25 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	110	—	—	110
HEATER	—	71.6	71.6	—
WATER PUMP	—	29.4	29.4	—
TOTAL	32.3 (110) WATT (BTU/HR)	29.6 (101) WATT (BTU/HR)	29.6 (101) WATT (BTU/HR)	32.3 (110) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
—N/A—					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 6/DISPOSABLE CLEANING CLOTHS/DISPOSABLE DRY WIPES INDEX NUMBER 3.1.1.6

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
SQUEEZER/WATER DISPENSER (McDAC)	32.4	1.15
DISPOSABLE CLEANING CLOTHS	60.72	30.19
DISPOSABLE DRY WIPES	41.4	4.14
TOTAL	61.0 (134.5) KG (LBS)	1.0 (35.43) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT) (REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
DISPOSABLE CLEANING CLOTHS	.2	.077 (N.A.) .1075 (170)	.022	.1092	.01092
DISPOSABLE DRY WIPES	1 (236)	.015 (236)	.015	.0015 (236)	.0015
		Σ③	.037 TOTAL WT/CYCLE (LB)	Σ⑤	.0124 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .037 TOT.WT/CYCLE (LB) = 46.32 (102.12) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0124 TOT.VOL/CYCLE (FT³) = .97 (34.28) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5 (236)	1-.0009	.4995	.0005
WATER LOSS 6	.025	N/A	N/A	.025
WATER LOSS (DRY WIPES)	.0490	N/A	N/A	.0490
OXYGEN (WIPE DISPOSAL)	.000719	N/A	N/A	.000714
Σ①	.575		Σ④	.0752

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0752 TOTAL LOST/CYCLE (Σ④) = 207.6 (LB) · .575 (Σ①) = 94.42 (208.2) KG (LB)

SPACECRAFT Space Station

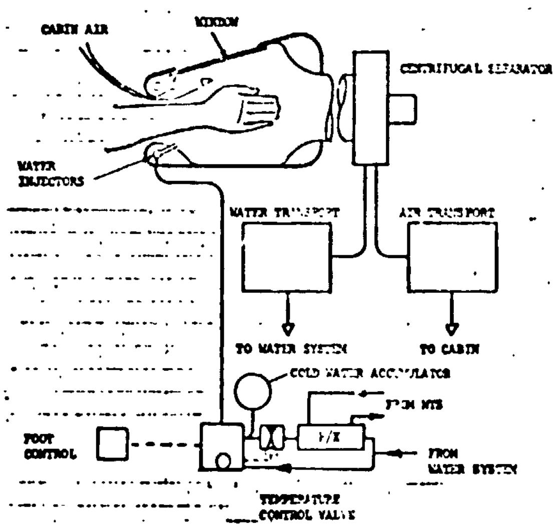
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

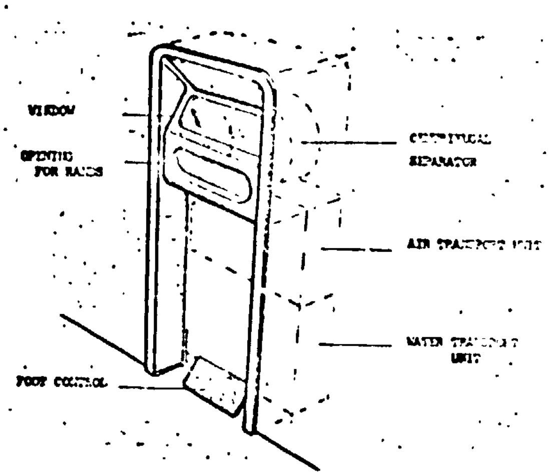
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 7/Disposable Wet Wipes/Reusables Dry Wipes

INDEX NO. 3.1.1.7 REF. NO. 286,186

DESCRIPTION The disposable wet wipes/reusable dry wipes concept is identical to concept 1, however reusable dry wipes are used for equipment drying. The terry cloth reusable dry wipes are 15 inches x 30 inches and are used a maximum of 5 times before washing. The wipes are washed and dryed after one day of usage and are discarded after 60 washings. The dry wipes are provisioned 3 per day for a maximum of 15 cleanup functions. The concept is penalized for the usage of a washer/dryer for recycling the drying cloths.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 7/DISPOSABLE WET WIPES/REUSABLE DRY WIPES   INDEX NUMBER 3.1.1.7

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTING UNIT (3%)	.0375	500	360	13.5	—	—	—
		500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
WASHER	465	—	22	18.5	1.66
DRYER	33.6	62.5	27.7	7.4	1.63
TOTAL	142.2 WATTS/CYCLE (498.6) (BTU/HR/CYCLE)	18.3 WATTS/CYCLE (62.5) (BTU/HR/CYCLE)	49.7	11.7 KG/MISSION (25.9) (LB/MISSION)	.093 M^3/MISSION (3.29) (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 7/DISPOSABLE WET WIPES/REUSABLE DRY WIPES INDEX NUMBER 3.1.1.7

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	76.69	185.0
DISPOSABLE WET WIPES		41.40	4.14
REUSABLE DRY WIPES		.403	.17
TOTAL		53.75 (118.493) KG (LBS)	5.35 (189.31) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WET WIPES	1 (236)	.015 (236)	.015	.0015	.0015
REUSABLE DRY WIPES	.0166	.0055 (236)	.000148	.00366 (236)	.0000608

Σ③ .015148 TOTAL WT/CYCLE (LB) Σ⑤ .0015608 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .015148 TOT.WT/CYCLE (LB) = 18.96 (41.81) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0015608 TOT.VOL/CYCLE (FT^3) = 1.22 (4.31) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WATER LOSS (WET WIPES)	.0454	N/A	N/A	.0454
OXYGEN (WIPE DISPOSAL)	.000719	N/A	N/A	.000719
WASHER WATER LOSS PENALTY	5.1	1-.0009	5.0954	.00459

Σ① 5.65 Σ④ .05121

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .05121 TOTAL LOST/CYCLE (Σ④) = 141.34 (LB) + 5.64 (Σ①) = 66.67 (146.99) KG (LB)

SPACECRAFT Space Station

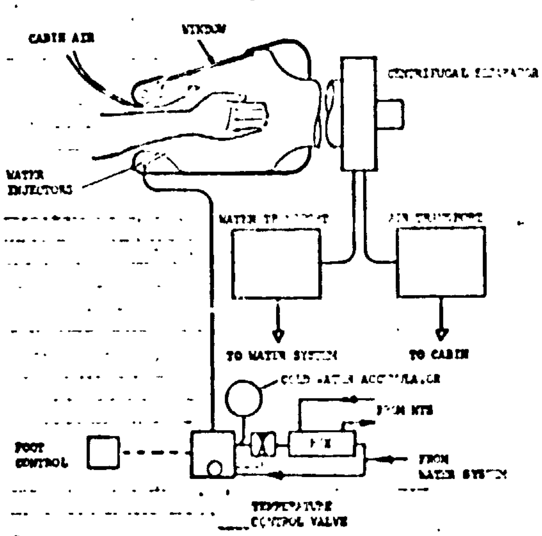
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

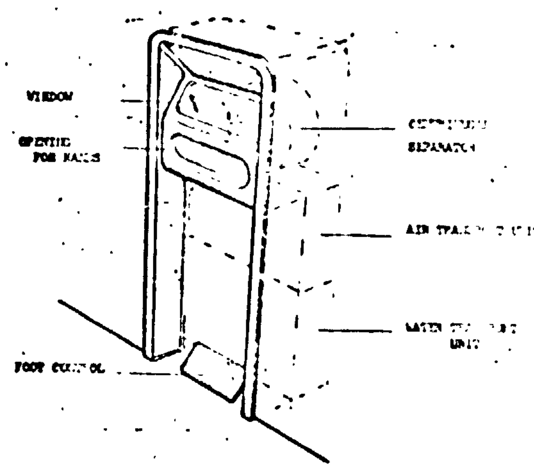
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 8/Reusable Wet/Dry Wipes

INDEX NO. 3.1 1.8 REF. NO. 236,186

DESCRIPTION The reusable wet/dry wipes concept is identical to concept 2; however reusable dry wipes are used for equipment drying. The terry cloth reusable dry wipes are used a maximum of 5 times before washing. The wipes are washed and dried after one day of usage and are discarded after 60 washings. The dry wipes are provisioned 3 per day for a maximum of 15 cleanup functions. The concept is penalized for the usage of a washer/dryer for recycling the cleaning and drying cloths.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/REUSABLE WET/DRY WIPES

INDEX NUMBER 3.1.1.8

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(7)
WETTING UNIT (2%)		.0375	500	360	13.5	—	—	—
			500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
WASHER	547	—	25.9	21.77	1.95
DRYER	39.4	73.6	32.6	8.71	1.92
TOTAL	172 (586.4) WATTS/CYCLE (BTU/HR/CYCLE)	21.6 (73.6) WATTS/CYCLE (BTU/HR/CYCLE)	58.5	13.83 (30.48) KG/MISSION (LB/MISSION)	.109 (3.87) M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 8/REUSABLE WET/DRY WIPES   INDEX NUMBER 3.1.1.8

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	28.49	3.5
REUSABLE WET WIPES		.18	.12
REUSABLE DRY WIPES		.16	.16
TOTAL		13.1 (28.83) KG (LBS)	.107 (3.78) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WET WIPES	.0167 (236)	.004 (236)	.0000668	.00252 (236)	.0000421
DRY WIPES	.0167 (236)	.0088 (236)	.000148	.00366 (236)	.0000608

Σ③ .000214 TOTAL WT/CYCLE (LB)   Σ⑤ .0001029 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .000124 TOT.WT/CYCLE (LB) = .155 (.34) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0001029 TOT.VOL/CYCLE (FT^3) = .008 (.28) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WASHER WATER LOSS PENALTY	5.22	1-.0009	5.2153	.0047

Σ① 5.72   Σ④ .0052

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0052 TOTAL LOST/CYCLE (Σ④) = 14.35 (LB) + 5.72 (Σ①) = 9.1 (20.07) KG (LB)

SPACECRAFT Space Station

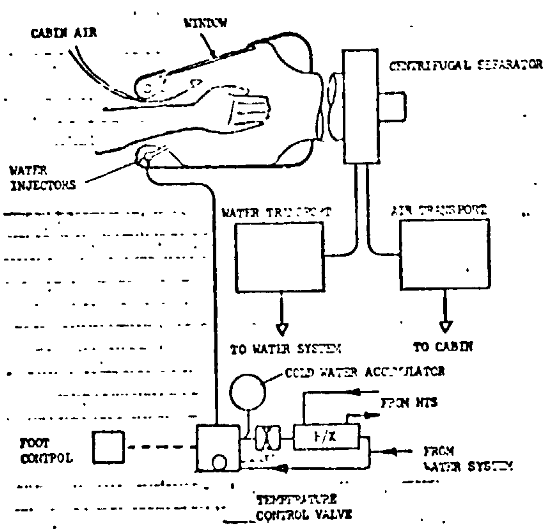
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

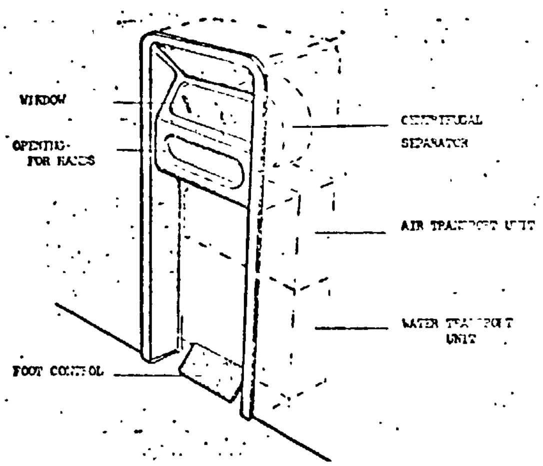
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 9/Reusable Cleaning Cloths/Dry Wipes

INDEX NO. 3.1.1.9 REF. NO. 236,237,245

DESCRIPTION The reusable cleaning cloths/dry wipes concept is identical to concept 5; however, reusable dry wipes are used for equipment drying. The terry cloth reusable dry wipes are used a maximum of 5 times before washing. The wipes are washed and dried after one day of usage and are discarded after 60 washings. The dry wipes are provisioned 3 per day for a maximum of 15 cleanup functions. The concept is penalized for the usage of a washer/dryer for recycling the cleaning and drying cloths.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 9/REUSABLE CLEANING CLOTHS/DRY WIPES INDEX NUMBER 3.1.1.9

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTI 3 UNIT	(234)	.0375	500	360	13.5	—	—	—
			500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
WASHER	636	—	30	25.3	2.27
DRYER	45.9	85.4	37.7	10.1	2.23
TOTAL	181.5 (681.9) WATTS/CYCLE (BTU/HR/CYCLE)	25.0 (85.4) WATTS/CYCLE (BTU/HR/CYCLE)	67.7	16.06 (35.4) KG/MISSION (LB/MISSION)	.127 (4.50) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 9/REUSABLE CLEANING CLOTHS/DRY WIPES INDEX NUMBER 3.1.1.9

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	28.49	3.5
CLEANING CLOTHS		3.59	2.51
REUSABLE DRY WIPES		.41	.17
TOTAL		14.74 (32.49) KG (LBS)	.175 (6.18) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
CLEANING CLOTHS	.0166 (236)	.077	.0013	.0546 (209)	.00091
REUSABLE DRY WIPES	.0167 (236)	.0089	.000148	.00366 (236)	.0000608

Σ③ .001448 TOTAL WT/CYCLE (LB) Σ⑤ .0009708 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .001448 TOT.WT/CYCLE (LB) = 1.813 (4.0) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0009708 TOT.VOL/CYCLE (FT^3) = .076 (2.68) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WASHER WATER LOSS PENALTY	5.25	1-.0009	5.2453	.0047

Σ① 5.75 Σ④ .0052

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0052 TOTAL LOST/CYCLE (Σ④) = 14.35 (LB) + 5.72 (Σ①) = 9.1 (20.07) KG (LB)

SPACECRAFT Space Station

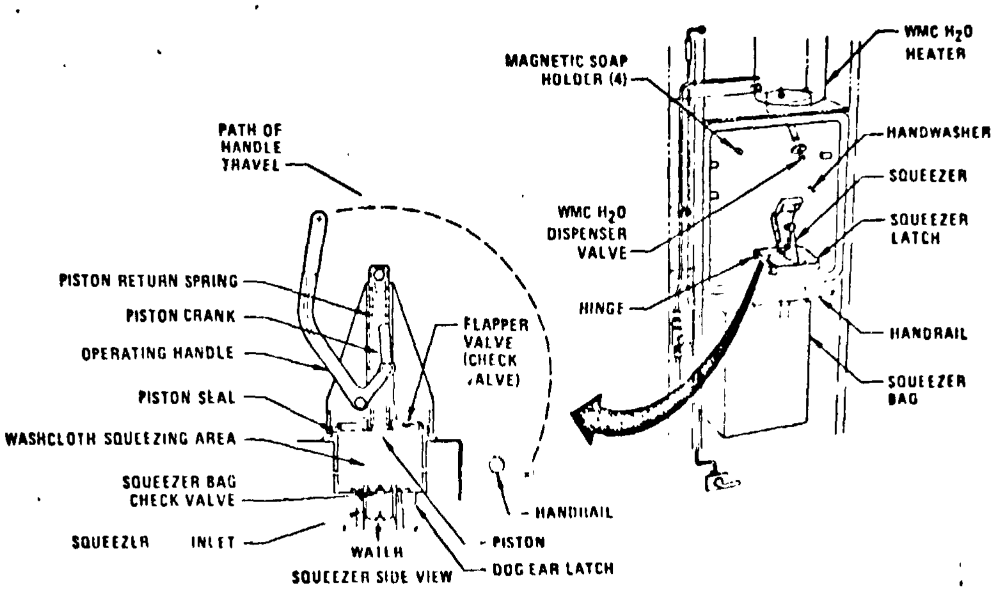
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

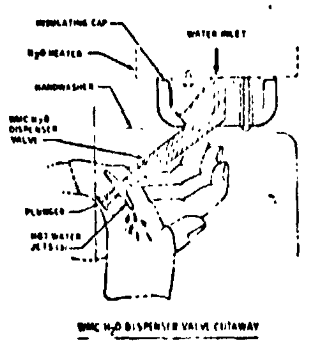
APPLIANCE FUNCTION Surface Wiping

APPLIANCE CONCEPT NO./TITLE 10/Disposable Cleaning Cloths/Reusable Dry Wipes

INDEX NO. 3.1.1.10 REF. NO. 236,283

DESCRIPTION The disposable cleaning cloths/reusable dry wipes concept is identical to concept 6; however reusable dry wipes are used for equipment cleaning. The terry cloth reusable dry wipes are used a maximum of 5 times before washing. The wipes are washed and dried after one day of usage and are discarded after 60 washings. The dry wipes are provisioned 3 per day for a maximum of 15 cleanup functions. The concept is penalized for the usage of a washer/dryer for recycling the drying cloths.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 10/DISPOSABLE CLEANING CLOTHS/REUSABLE DRY WIPES INDEX NUMBER 3.1.1.10

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
HEATER (293)	.0375	—	—	—	140	140	5.25
WATER PUMP	.0375	57.5	57.5	2.15			
		57.5 MAXIMUM		2.15 TOTAL	140 MAXIMUM		5.25 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	110	—	—	110
HEATER	—	71.6	71.6	—
WATER PUMP	—	29.4	29.4	—
TOTAL	32.3 (110) WATT (BTU/HR)	29.6 (101) WATT (BTU/HR)	29.6 (101) WATT (BTU/HR)	32.3 (110) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
WASHER	465	—	22	18.50	1.66
DRYER	33.6	62.5	27.7	7.40	1.63
TOTAL	142.2 (498.6) WATTS/CYCLE (BTU/HR/CYCLE)	18.3 (62.5) WATTS/CYCLE (BTU/HR/CYCLE)	49.7	11.7 (25.9) KG/MISSION (LB/MISSION)	.093 (3.29) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 10/DISPOSABLE CLEANING CLOTHS/REUSABLE DRY WIPES INDEX NUMBER 3.1.1.10

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
SQUEEZER/WATER DISPENSER (McDAC)	32.4	1.15
DISPOSABLE CLEANING CLOTHS	60.72	30.14
REUSABLE DRY WIPES	.41	.17
TOTAL	42.43 (93.53) KG (LBS)	.89 (31.46) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DISPOSABLE CLEANING CLOTHS	.2	.077 (NASA) .1078 (100)	.022	.1092	.01092
REUSABLE DRY WIPES	.0167 (236)	.0088	.000148	.00366 (236)	.0000608

Σ③ .022148 TOTAL WT/CYCLE (LB) Σ⑤ .0109808 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .022148 TOT.WT/CYCLE (LB) = 27.73 (61.13) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .0109808 TOT.VOL/CYCLE (FT^3) = .858 (30.31) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WASHER WATER LOSS PENALTY	5.1	1-.0009	5.0954	.0046
WATER LOSS (CLEANING CLOTH)	.025	N/A	N/A	.025

Σ① 5.625 Σ④ .0301

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0301 TOTAL LOST/CYCLE (Σ④) = 83.09 (LB) + 5.6 (Σ①) = 40.2 (88.7) KG (LB)

SPACECRAFT Space Station

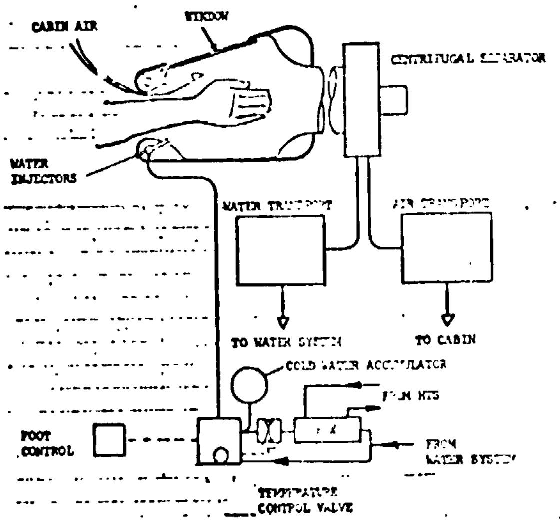
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

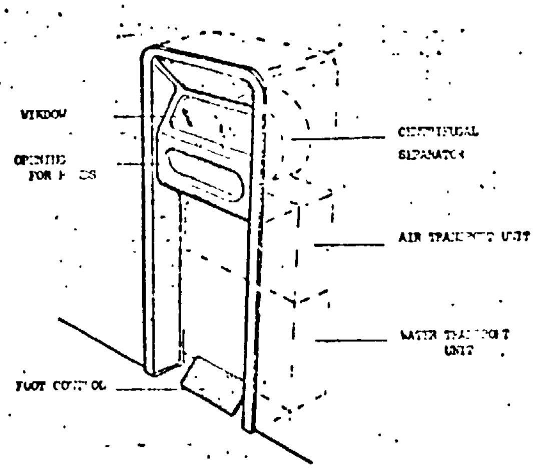
APPLIANCE FUNCTION Surface Wiping

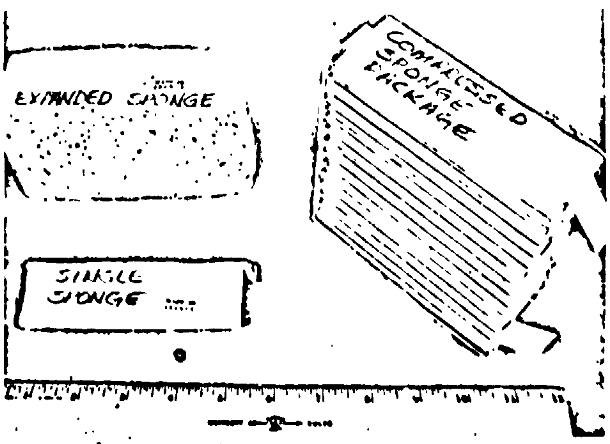
APPLIANCE CONCEPT NO./TITLE 11/Sponges/Enclosed Wetting Unit

INDEX NO. 3.1.1.11 REF. NO. 236,170

DESCRIPTION The sponges/enclosed wetting unit concept uses the wetting unit described by concept 1. The sponges are compressed and are used for pickup of spills of any type and general cleanup. The sponges are made of cellulose material which expands to approximately 15 times its compressed volume when soaking up liquid. A single compressed sponge is 5 inches long by 1.6 inches wide by .25 inches depth. The sponge volume is 2.0 cubic inches and weighs 18 grams. The wetting unit is used for wetting/wringing the sponges during cleanup. The sponges are used for cleanup and drying. Five sponges per day are provisioned for a maximum of 15 cleanup and drying functions. Each sponges is used 3 times and discarded into the refuse system.







APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 11/SPONGES/ENCLOSED WETTING UNIT   INDEX NUMBER 3.1.1.11

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
WETTING UNIT (2%)	.0375	500	360	13.5	—	—	—
		500 MAXIMUM		13.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	360	—	—	360
MOTORS	—	948	948	—
TOTAL	105.6 (360) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (360) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 11/SPONGES/ENCLOSED WETTING UNIT INDEX NUMBER 3.1.1.11

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
WETTING UNIT	(236)	28.49	3.5
SPONGES	(170)	36.46	1.06
TOTAL		29.46 (64.95) KG (LBS)	.129 (4.56) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
SPONGES	.333	.0397 (170)	.01321	.00116 (170)	.000385

Σ③ .01321 TOTAL WT/CYCLE (LB) Σ⑤ .000385 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .01321 TOT.WT/CYCLE (LB) = 16.54 (36.46) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .000385 TOT.VOL/CYCLE (FT^3) = .030 (1.06) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WATER LOSS (SPONGE DISPOSAL)	.0083	N/A	N/A	.0083

Σ① .5083 Σ④ .0088

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0088 TOTAL LOST/CYCLE Σ④ = 24.29 (LB) = .5083 Σ① = 11.25 (24.8) KG (LB)

SPACECRAFT Space Station

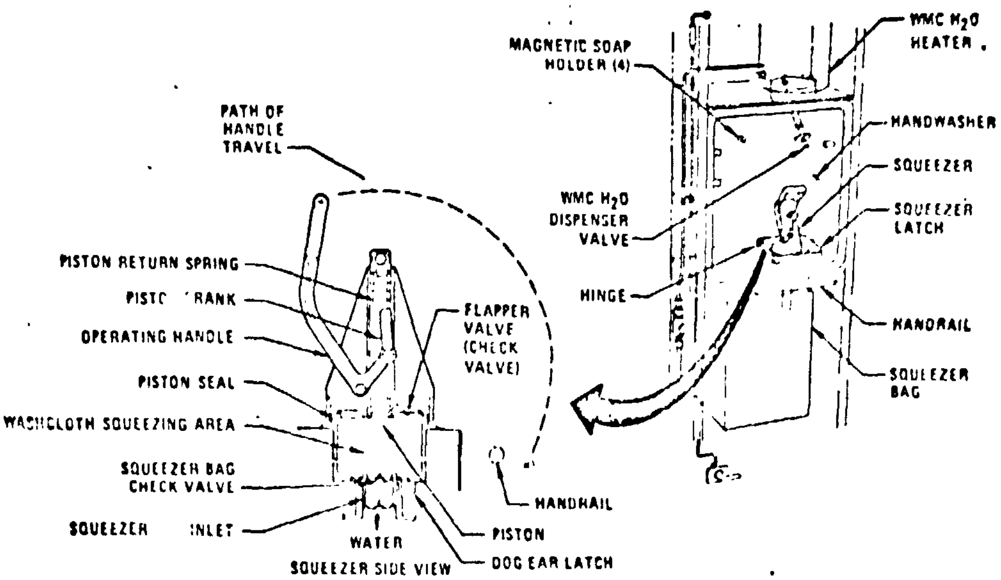
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Equipment Cleaning

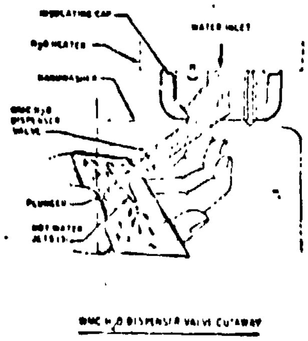
APPLIANCE FUNCTION Surface Wiping

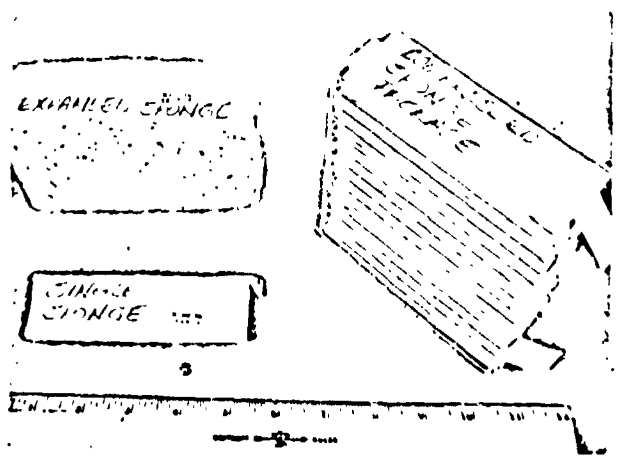
APPLIANCE CONCEPT NO./TITLE 12/Sponges/Skylab Wetting Unit

INDEX NO. 3.1.1.12 REF. NO. 236,170

DESCRIPTION The sponges/Skylab wetting unit concept is identical to concept 11; however the Skylab wetting unit is used for sponge wetting/rinsing.







APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 12/SPONGES/SKYLAB WETTING UNIT INDEX NUMBER 3.1.1.12

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
HEATER	(283)	.0375	—	—	—	140	140	5.25
WATER PUMP		.0375	57.5	57.5	2.15			
			57.5 MAXIMUM		2.15 TOTAL	140 MAXIMUM		5.25 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	110	—	—	110
HEATER	—	71.6	71.6	—
WATER PUMP	—	29.4	29.4	—
TOTAL	32.3(110) WATT (BTU/HR)	29.6(101) WATT (BTU/HR)	29.6(101) WATT (BTU/HR)	32.3(110) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
— N/A —					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 12/SPONGES/SKYLAB (WETTING UNIT　　INDEX NUMBER 3.1.1.12

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
SQUEEZER/WATER DISPENSER	(McDAC)	32.4	1.15
SPONGES	(170)	36.46	1.06
TOTAL		31.23 (68.86) KG (LBS)	.063 (2.21) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
SPONGES	.333	.0397 (170)	.01321	.00116 (170)	.000385
		Σ③	.01321 TOTAL WT/CYCLE (LB)	Σ⑤	.000385 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .01321 TOT.WT/CYCLE (LB) = 16.54 (36.46) KG (LB)

TOTAL VOL MISSION = 15 CYCLES/DAY x 184 DAYS/MISSION x .000385 TOT.VOL/CYCLE (FT³) = .030 (1.06) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WATER	.5	1-.0009	.4995	.0005
WATER LOSS (SPONGE DISPOSAL)	.0083	N/A	N/A	.0083
Σ①	.5083		Σ④	.0088

TOTAL WT. MISSION = 15 CYCLE/DAY x 184 DAYS/MISSION x .0088 TOTAL LOST/CYCLE Σ④ + 24.29 (LB) + .5083 Σ① = 11.25 (24.8) KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.2 Refuse Management

APPLIANCE FUNCTION 3.2.1 Manual Collection

NUMBER OF CONCEPTS CONSIDERED 3

ASSUMPTIONS

1. The manual collection of refuse utilizes crewman collection of refuse. The collection devices considered were bags and stationary containers.
2. The refuse mix used for the compressible/noncompressible refuse is summarized on the next page. The refuse mix was based on reference 203.
3. The total compressible and uncompressible refuse volume was divided by the volumetric capacity of the collection devices to obtain the total number of devices required for the missions.
4. The study assumed no compaction for the compressible trash collection devices. Reference material stated that 20 percent compressible was possible by manual compaction by the crewman. However, the conservative approach was taken by assuming no trash compaction because of the variety of collection devices presented the 20 percent might not always apply.
5. The weights and volumes of the refuse from all sources are summarized in Table C2-6.

TABLE C2-6

SPACE STATION/SHUTTLE REFUSE SUMMARY

		SPACE STATION (LBS)	SHUTTLE (LBS)	SPACE STATION (FT³)	SHUTTLE (FT³)
TRASH BAGS	COMPRESSIBLE				
	Health & Safety	11.10	1.296	11.59	.372
	Crew Quarters	120.62	115.4	128.7	2.39
	Food/Drink	566.2	32.93	13.08	.993
	Crew Hygiene	171.32	107.58	129.36	2.48
	ECS	0	0	0	0
	RCS	0	0	0	0
	Power	0	0	0	0
	Structural Maintenance	21.15	.236	.281	.030
	Communications	0	0	0	0
	Data Collection	.25	0	.006	0
	COMPRESSIBLE REFUSE TOTAL	890.64	257.44	283.02	6.265
	NONCOMPRESSIBLE				
	Health & Safety	0	0	0	0
	Crew Quarters	0	0	0	0
	Food/Drink	0	0	0	0
	Crew Hygiene	0	0	0	0
	ECS	0	0	0	0
	RCS	0	0	0	0
	Power	0	0	0	0
	Structural Maintenance	0	0	0	0
	Communications	0	0	0	0
	NONCOMPRESSIBLE REFUSE TOTAL	0	0	0	0
DISPOSAL BAGS	COMPRESSIBLE				
	Health & Safety	144.0	10.80	5.14	.386
	Crew Quarters	0	0	0	0
	Food/Drink	3975.56	314.12	158.37	12.237
	Crew Hygiene	61.42	2.67	3.64	.095
	ECS	36.98	6.95	.57	.43
	RCS	1.75	0	.04	0
	Power	0	0	0	0
	Structural Maintenance	0	0	0	0
	Communications	0	0	0	0
	COMPRESSIBLE REFUSE TOTAL	4219.71	334.54	167.76	13.15
	NONCOMPRESSIBLE				
	Health & Safety	0	0	0	0
	Crew Quarters	0	0	0	0
	Food/Drink	0	0	0	0
	Crew Hygiene	11.38	.39	.72	.002
	ECS	26.17	0	.14	0
	RCS	207.03	0	13.43	0
	Power	55.16	0	.730	0
	Structural Maintenance	51.25	0	.206	0
	Communications	96.998	0	1.82	0
	Data Collection	8.31	0	.078	0
	NONCOMPRESSIBLE	456.30	.39	17.12	.002

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.2.1 **** MANUAL REFUSE COLLECTION (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	.000 .000						0. (0.)	0. (0.)	.0 .0	.0 .0	153.1 (337.6)	.64 (22.51)	1	5	144.9 (319.0)
2	.000 .000						0. (0.)	0. (0.)	.0 .0	.0 .0	151.5 (334.0)	1.56 (55.14)	1	20	110.2 (243.0)
3	.000 .000						0. (0.)	0. (0.)	.0 .0	.0 .0	152.5 (336.1)	.96 (33.97)	1	20	144.2 (318.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1	DISPOSABLE TRASH BAG
2	REUSABLE WASTE RECEPTICLES
3	DISPOSABLE WASTE RECEPTICLES

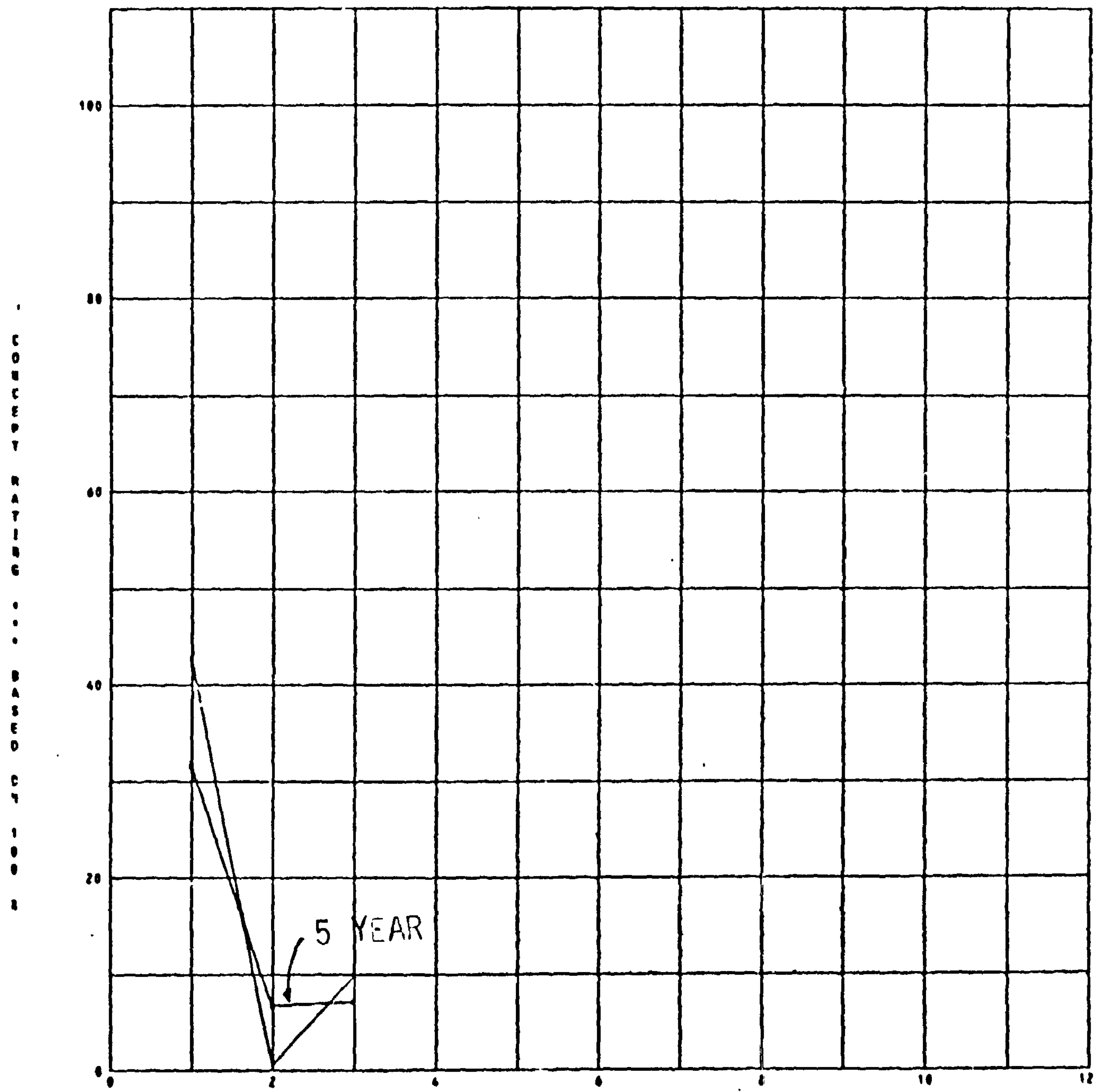
(*)

1 -	CABIN AIR	(CIRCULATED),	LITERS/SEC	(FT^3/MIN)
2 -	CABIN AIR	(LOST) ,	KG/HR	(LB/HR)
3 -	OXYGEN	(LOST) ,	KG/HR	(LB/HR)
4 -	COOLING WATER	(CIRCULATED),	KG/HR	(LB/HR)
5 -	WATER	(LOST) ,	KG/HR	(LB/HR)
6 -	NITROGEN	(CIRCULATED),	KG/HR	(LB/HR)
7 -	NITROGEN	(USED) ,	KG/HR	(LB/HR)
8 -	FREON	(CIRCULATED),	KG/HR	(LB/HR)
9 -	WATER	(PROCESSED) ,	KG/HR	(LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

ok

APPLIANCE CONCEPT NO.	CONCEPT NAME
1	- DISPOSABLE TRASH BAG
2	- REUSABLE WASTE RECEPTICLES
3	- DISPOSABLE WASTE RECEPTICLES



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CONCEPT NUMBER

Manual Refuse Collection (Space Station)
Concept Trade
C2-400

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 0
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100

SELECTION MATRIX • • • • • MANUAL REFUSE COLLECTION (SPACE STATION)
(12/09/74)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	334.00	337.60	15	.00	.16	.07
VOLUME	22.510	55.140	10	5.92	.00	3.84
DEV COST	5.0000	20.000	15	11.25	.00	.00
TOTAL PT	.00000	40.000	40	17.17	.16	3.91
RATING	.00000	100.00	100	42.92	.40	9.76

0073375

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	42.92	.40	9.76
WEIGHT	36.14	.51	8.29
VOLUME	44.73	.36	12.95
DEV COST	47.98	.34	8.22

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	42.92	.40	9.76
WEIGHT	52.82	.25	11.92
VOLUME	40.60	.46	5.68
DEV COST	35.52	.49	12.02

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 0
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100

SELECTION MATRIX • • • • • MANUAL REFUSE COLLECTION (SPACE STATION)
(12/09/74)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	334.00	337.60	15	.00	.16	.07
VOLUME	22.510	55.140	10	5.92	.00	3.84
DEV COST	5.0000	20.000	15	11.25	.00	.00
REC COST	243.00	318.00	15	.19	3.54	.00
TOTAL, PT	.00000	55.000	55	17.36	3.70	3.91
RATING	.00000	100.00	100	31.56	6.72	7.10

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	31.56	6.72	7.10
WEIGHT	27.77	6.04	6.30
VOLUME	33.86	6.16	9.71
DEV COST	36.77	5.92	6.25
REC COST	27.92	8.75	6.25

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	31.56	6.72	7.10
WEIGHT	36.54	7.62	8.15
VOLUME	28.80	7.40	3.97
DEV COST	24.70	7.78	8.22
REC COST	36.34	4.06	8.22

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.2.1-REFUSE/MANUAL COLLECTION

COMPONENT TYPE / APPLIANCE TYPE	NUMBER OF COMPONENTS																NUMBER OF SAFETY CRITICAL ITEMS
NO.																	
					NO MECHANICAL/ELECTRICAL COMPONENTS												

SPACECRAFT Space Station

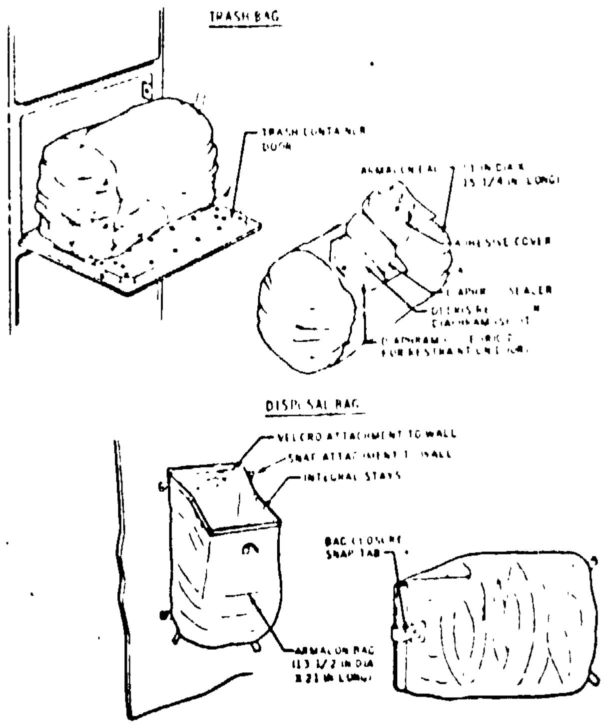
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Manual Collection

APPLIANCE CONCEPT NO./TITLE 1/Waste/Trash Bags

INDEX NO. 3.2.1.1 REF. NO. 283,203,170,297

DESCRIPTION The waste/trash bags concept employs trash bags and disposable bags for refuse collection. This concept uses the bag concept used on Skylab. The trash containers are mounted on the back side of collector doors. The collector areas are located in the food management, personal hygiene, and other areas where significant amount of bulk refuse is generated. The study assumed 15 collectors for Space Station and 3 collectors for Shuttle. Trash entry into the bag is through the front of the collection door through a slit in the bag. The refuse collection was based on its uncompressed volume. Disposable bags were applied for uncompressible trash. The disposable bags are held during use by snaps located at various locations throughout the vehicle. Both types of bags have bag closure devices to seal the bag after filling.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *I/WASTE/TRASH BAGS* INDEX NUMBER *3.2.1.1*

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 1/WALL/TRASH BAGS — INDEX NUMBER 3.2.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTION DEVICE • (253)	15.0	13.6
TRASH BAGS	240.8	6.37
DISPOSABLE BAGS	81.7	2.43
TOTAL	153.1 (337.5) KG (LBS)	.634 (22.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/~~CYCLE~~ DAY (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/~~CYCLE~~ DAY ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/~~CYCLE~~ DAY ①x④ (FT^3)
TRASH BAGS	1.87	.7 (McDAC)	1.309	.0185 (McDAC)	.0346
DISPOSABLE BAGS	.59	.75 (McDAC)	.444	.0224 (McDAC)	.0132
			Σ③ 1.753 TOTAL WT/CYCLE (LB)		Σ⑤ .0478 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x 1.753 TOT.WT/CYCLE (LB) = 146.3 (322.5) KG (LB)

TOTAL VOL MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x .0478 TOT.VOL/CYCLE (FT^3) = .249 (8.79) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
- N/A -				
	Σ①			Σ④

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x ____ TOTAL LOST/CYCLE Σ④ = ____ (LB) + ____ Σ① = ____ KG (LB)

SPACECRAFT Space Station

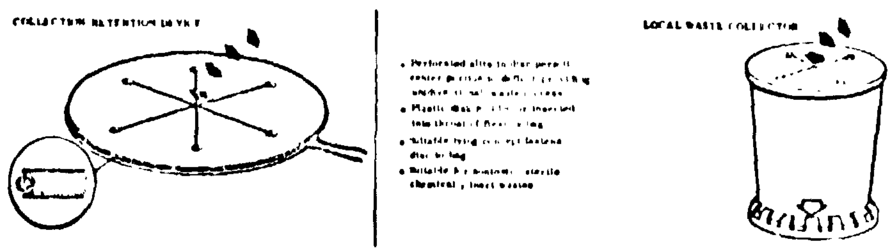
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Manual Collection

APPLIANCE CONCEPT NO./TITLE 2/Waste Receptacles/Reusable

INDEX NO. 3.2.1.2 REF. NO. 170,160

DESCRIPTION The waste receptacles/reusable concept utilizes aluminum rigid trash containers with tops with perforated slits. Replaceable plastic liner bags are used for refuse transport. The containers are held to structure with steel spring-finger retainer strategically placed throughout the vehicle. The number of containers used for space station were 30 and 6 for Shuttle. The number of containers was based on the fact the collectors are at fixed locations within the vehicles. The same container was used for compressible and uncompressible refuse. The number of plastic liners provided for the concept were based on the refuse volume. The plastic liners were assumed to be changed every 5 days based on volume of .68 FT^3/collector (15 liners/5 days for Space Station, .634 liners/5 days for Shuttle). The liner volume was assumed to be .27 FT^3 less than container volume to allow for positive closure.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/WASTE RECEPTACLES/REUSABLE INDEX NUMBER 3.2.1.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2 [illegible] INDEX NUMBER 3.2.12

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTOR	(170)	52	31.2
COLLECTOR [illegible]	(170)	33	.135
PLASTIC LINERS		247.3	23.7
TOTAL		150.7 (332.3) KG (LBS)	1.56 (55.03) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/DAY (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/DAY ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/DAY ①x④ (FT^3)
PLASTIC LINERS	3 (AVERAGE)	.448 (170/253)	1.344	.0429 (170)	.1287

Σ③ 1.344 TOTAL WT/CYCLE (LB)

Σ⑤ .1287 TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x 1.344 TOT.WT/DAY (LB) = 112.2 KG (LB) (247.3)

TOTAL VOL./MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x .128 TOT.VOL/DAY (FT^3) = .670 M^3 (FT^3) (23.7)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
-N/A-				

Σ① ______ Σ④ ______

TOTAL WT./MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ ④) ÷ ______ (LB) (Σ ①) = ______ KG (LB)

SPACECRAFT Space Station

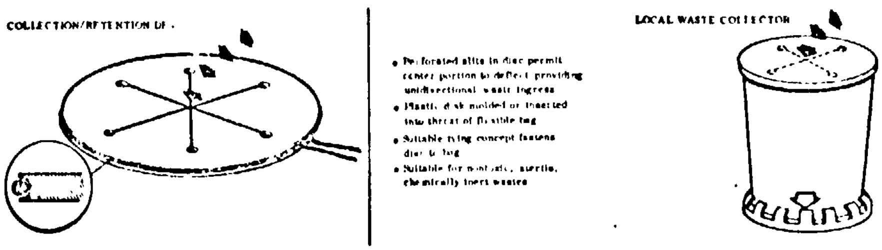
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Manual Collection

APPLIANCE CONCEPT NO./TITLE 3/Waste Receptacles/Disposable

INDEX NO. 3.2.1.3 REF. NO. 170,160

DESCRIPTION The waste receptacles/disposable concept is identical to concept 2 using disposable plastic containers. Plastic liners were not used since the disposable container provides the means of refuse transport. The disposable plastic collectors are held to the structure with plastic spring-finger retainers. The spring retainers are strategically located throughout the vehicles (30 for Space Station; 6 for Shuttle). The number of plastic collectors were based on the trash volume (2.16 per day for Space Station; .83 per day for Shuttle) based on .95 FT^3/collector. The storage volume of the containers was based on a stacked configuration, i.e. like paper cup storage.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/WASTE RECEPTACLES/DISPOSABLE INDEX NUMBER 3.2.1.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/WASTE RECEPTACLES/DISPOSABLE INDEX NUMBER 3.2.1.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
RETAINERS (170)	11.10	.13
DISPOSABLE CONTAINER	325.1	33.84
TOTAL	152.5 (336.2) KG (LBS)	.96 (33.97) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/~~CYCLE~~ DAY (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/~~CYCLE~~ DAY ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/~~CYCLE~~ DAY ①x④ (FT^3)
DISPOSABLE CONTAINER	2.16	.818	1.767	1.04 (INITIAL UNIT) .0826	.1784

Σ③ 1.767 TOTAL WT/CYCLE (LB)

Σ⑤ .1784 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x 1.767 TOT.WT/CYCLE (LB) = 147.5 (325.1) KG (LB)

TOTAL VOL MISSION = N/A CYCLES/DAY x 184 DAYS/MISSION x .1784 TOT.VOL/CYCLE (FT^3) +1.04 = .958 (33.84) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
- N/A -				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ ④) = ______ (LB) + ______ (Σ ①) = ______ KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.2 Refuse Management

APPLIANCE FUNCTION 3.2.2 Vacuum Collection

NUMBER OF CONCEPTS CONSIDERED 3

ASSUMPTIONS

1. The vacuum collection of refuse utilizes various types of vacuum cleaners. to assist in cleaning of the vehicles. A central vacuum system was not considered because sizing of the unit is dependent on the detailed vehicle configuration. The configuration was not defined well enough to size a representative system for trade purposes, therefore only hand held units were considered for the study.
2. The vacuum usage was based on 24.5 minutes per day. This was based on the following rationale.

(1 use/day) 8.5 minutes/day (1 hr/week)-general cleanup
(3 uses/day) 6.0 minutes/day (2 min/meal)-meal cleanup
(1 use/day) 10.0 minutes/day - emergency cleanup

24.5 minutes per day (.408 hrs/day)

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.2.2 .... VACUUM REFUSE COLLECTION (SPACE STATION)

CONCEPT NO.	USAGE TIME: USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS: TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS: COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS: PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS: WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST: AVAIL (**)	INDEX (***)	RESUPPLY: WEIGHT -KG- (LBS)
1	5.000 .082						0. (0.)	77. (262.)	.0 115.0	.0 .0	13.8 (30.4)	.02 (.86)	1	5	.2 (.4)
2	5.000 .082						0. (0.)	160. (546.)	240.0 .0	.0 .0	4.7 (10.4)	.01 (.37)	1	20	.2 (.4)
3	5.000 .082	3	.6219 (1.3700)	4.59 (10.00)	.0 (.0)	21.1 (70.0)	0. (0.)	0. (0.)	.0 .0	.0 .0	574.9 (1267.4)	.01 (.26)	1	25	559.3 (1233.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	VACUUM CLEANER (SKYLAB)
2 -	VACUUM CLEANER (COMMERICAL)
3 -	VACUUM CLEANER-VENTED TO SPACE

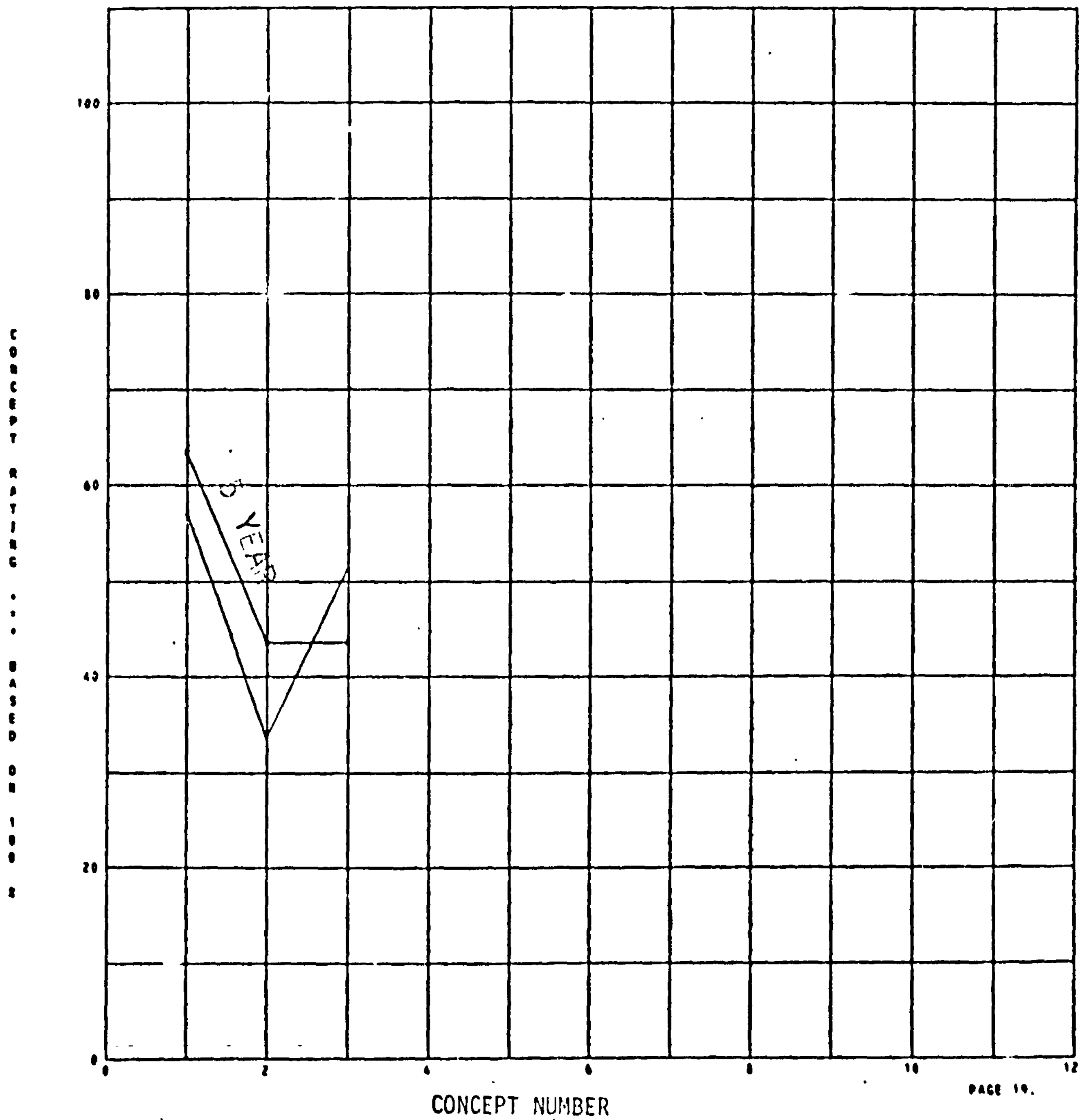
(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST), KG/HR (LB/HR)
3 - OXYGEN (LOST), KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST), KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED), KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED), KG/HR (LB/HR)

(**)AVAILABLE
(1) AVAILABLE
(2) STATE OF THE ART
(3) SOME DEVELOPMENT REQUIRED
(4) EXTENSIVE DEV. REQUIRED

(***)COST INDICATOR
0-25%
25-50%
50-75%
75-100%

ORIGINAL PAGE IS OF POOR QUALITY

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	VACUUM CLEANER (SKYLAB)
2 -	VACUUM CLEANER (COMMERICAL)
3 -	VACUUM CLEANER-VENTED TO SPACE



PAGE 19.

Vacuum Refuse Collection (Space Station)
Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 13
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • VACUUM REFUSE COLLECTION (SPACE STATION)
(01/19/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	10.440	1267.4	15	14.64	14.88	.00
POWER	.00000	170.40	15	9.02	.00	15.00
VOLUME	.26000	.86000	10	.00	5.70	6.98
THERMAL	.00000	69.888	15	7.80	.00	15.00
RELIAB-Y	.99874	.99949	5	.00	.00	2.98
MAINTENC	.99999	1.00000	5	.00	.00	3.65
SAFETY	.00000	1.0000	5	5.00	5.00	.00
DEV COST	5.0000	25.000	15	12.00	3.00	.00
TOTAL PT	.00000	85.000	85	48.46	28.57	43.61
RATING	.00000	100.00	100	57.01	33.62	51.30

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	57.01	33.62	51.30
WEIGHT	60.30	38.93	47.14
POWER	57.26	30.89	55.25
VOLUME	53.84	34.91	52.33
THERMAL	56.61	30.89	55.25
RELIAB-Y	55.38	32.66	51.54
MAINTENC	55.38	32.66	51.92
SAFETY	58.24	35.51	49.84
DEV COST	58.87	32.51	47.14

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	57.01	33.62	51.30
WEIGHT	53.08	27.27	56.27
POWER	56.71	36.87	46.59
VOLUME	60.57	32.16	50.15
THERMAL	57.49	36.87	46.59
RELIAB-Y	58.74	34.64	51.05
MAINTENC	58.74	34.64	50.65
SAFETY	55.71	31.60	52.86
DEV COST	54.79	34.93	56.27

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 13
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • VACUUM REFUSE COLLECTION (SPACE STATION)
(01/19/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	10.440	1267.4	15	14.64	14.88	.00
POWER	.00000	170.40	15	9.02	.00	15.00
VOLUME	.26000	.86000	10	.00	5.70	6.98
THERMAL	.00000	69.888	15	7.80	.00	15.00
RELIAB-Y	.98725	.99484	5	.00	.00	2.98
MAINTENC	.99999	1.00000	5	.00	.00	3.65
SAFETY	.00000	1.0000	5	5.00	5.00	.00
DEV COST	5.0000	25.000	15	12.00	3.00	.00
REC COST	.43000	1233.0	15	14.99	14.99	.00
TOTAL PT	.00000	100.00	100	63.45	43.57	43.60
RATING	.00000	100.00	100	63.45	43.57	43.60

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	63.45	43.57	43.60
WEIGHT	65.84	47.45	40.56
POWER	63.22	40.53	47.54
VOLUME	60.43	44.21	44.85
THERMAL	62.66	40.53	47.54
RELIAB-Y	61.91	42.51	43.99
MAINTENC	61.91	42.51	44.32
SAFETY	64.35	44.95	42.54
DEV COST	64.61	41.92	40.56
REC COST	66.00	47.50	40.56

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	63.45	43.57	43.60
WEIGHT	60.69	39.06	47.14
POWER	63.72	47.10	39.03
VOLUME	66.79	42.86	42.22
THERMAL	64.38	47.10	39.03
RELIAB-Y	65.08	44.69	43.19
MAINTENC	65.08	44.69	42.85
SAFETY	62.52	42.12	44.72
DEV COST	62.11	45.48	47.14
REC COST	60.49	39.00	47.14

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.2.2-REFUSE/VACUUM COLLECTION

APPLIANCE TYPE \ COMPONENT TYPE	NUMBER OF COMPONENTS																NUMBER OF SAFETY CRITICAL ITEMS
	MOTOR	BLOWER (VACUUM)	FILTER	ACCUMULATOR	WATER SEPARATOR	CHECK VALVE	ELECTRIC SWITCH	SOLENOID VALVE									
NO.	1	2	9	4	6	23	10	3									
PORTABLE VACUUM CLEANER (SKYLAB)	1	1	1	1	1	1	1	-									0
PORTABLE VACUUM CLEANER (COMMERCIAL)	1	1	1	1	1	1	1	-									0
VACUUM CLEANER VENTING TO SPACE	-	-	1	1	-	1	1	1									1

SPACECRAFT Space Station

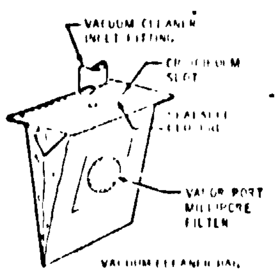
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

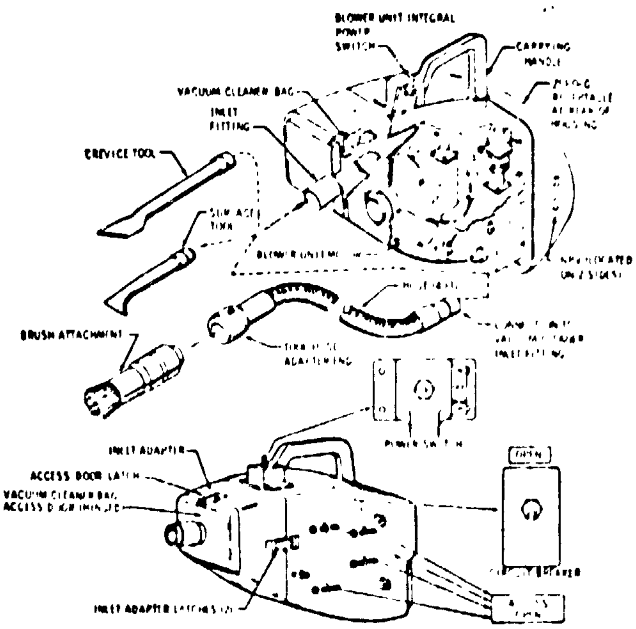
APPLIANCE FUNCTION Vacuum Collection

APPLIANCE CONCEPT NO./TITLE 1/Portable Vacuum/Electric (Skylab)

INDEX NO. 3.2.2.1 REF. NO. McDac, 297,283

DESCRIPTION The portable vacuum/electric is identical to the vacuum used on Skylab. The vacuum has a hose and pickup attachments to assist in vacuum pickup. The unit has a strap and handle for carrying/using the unit. Vacuum cleaner bags were assumed to require changing once per week (.142 cycles per day).





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *I/B CIMBLE VACUUM / ELECTRIC (SKYLAB)* INDEX NUMBER *3.2.7.1*

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑥
MOTOR	*(Skylab)*	*.102*	—	—	—	*115*	*115*	*11.73*
			MAXIMUM		TOTAL	*115* MAXIMUM		*11.73* TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTOR	—	*262*	*262*	—
TOTAL	WATT (BTU/HR)	*76.8 (262)* WATT (BTU/HR)	*76.8 (262)* WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
— N/A —					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT PORTABLE VACUUM/ELECTRIC (CRYSTAL)   INDEX NUMBER 3.2.2.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
VACUUM UNIT (W/ CLEANING HOSES AND ATTACHMENTS)	30.00	.78
VACUUM CLEANER BAGS	.444	.08
TOTAL	13.81 (30.44) KG (LBS)	.025 (.86) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
VACUUM CLEANER BAGS	1	.017 (1.5)	.017	.003067	.003067
		Σ③	.017 TOTAL WT/CYCLE (LB)	Σ⑤	.003067 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = .142 CYCLES/DAY x 184 DAYS/MISSION x .017 TOT. WT/CYCLE (LB) = .201 (.444) KG (LB)

TOTAL VOL MISSION = .142 CYCLES/DAY x 184 DAYS/MISSION x .003067 TOT. VOL/CYCLE (FT^3) = .00227 (.080) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
-N/A-				
Σ①			Σ④	

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE Σ④ ____ (LB) Σ① ____ = ____ KG (LB)

SPACECRAFT Space Station

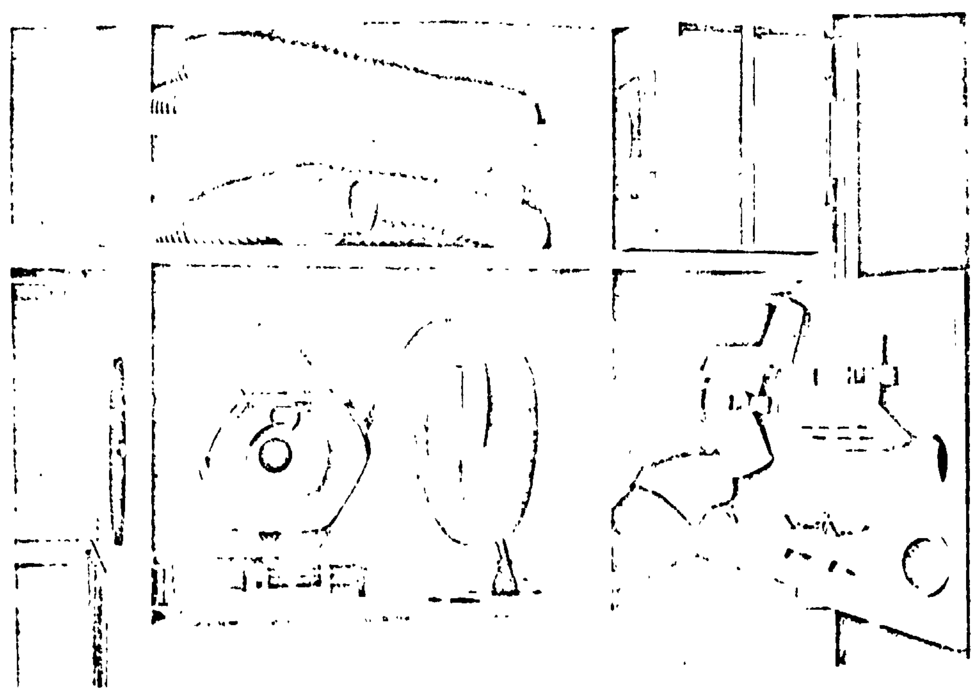
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Vacuum Collection

APPLIANCE CONCEPT NO./TITLE 2/Portable Vacuum/Electric (Commercial)

INDEX NO. 3.2.2.2 REF. NO. 170

DESCRIPTION The portable vacuum/electric (commercial) concept is the same as concept 1 except the unit is made of plastic and is a commercial unit operating on AC power. The unit is lighter than the concept 1 version, therefore was presented for the purposes of trade. The unit would require considerable development and was penalized for its development cost. The vacuum cleaner bags are identical to concept 1 and are replaced at the same frequency.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/PORTABLE VACUUM/ELECTRIC (COMMERCIAL) INDEX NUMBER 3.2.2.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
MOTOR	(170)	.102	240	240	24.5	—	—	—
			240 MAXIMUM		24.5 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTOR	—	546	546	—
TOTAL	WATT (BTU/HR)	160 (546) WATT (BTU/HR)	160 (546) WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/PORTABLE VACUUM/ELECTRIC (COMMERCIAL) INDEX NUMBER 3.2.2.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
VACUUM UNIT (INCLUDING HOSES AND ATTACHMENTS)	(170)	10.0	.293
VACUUM CLEANER BAGS		.444	.08
TOTAL		4.73 (10.44) KG (LBS)	.010 (.373) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
VACUUM CLEANER BAGS	1	.017 (170)	.017	.003067 (170)	.003067
		Σ③	.017 TOTAL WT/CYCLE (LB)	Σ⑤	.003067 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = .142 CYCLES/DAY x 184 DAYS/MISSION x .017 TOT.WT/CYCLE (LB) = (.201) (.444) KG (LB)

TOTAL VOL MISSION = .142 CYCLES/DAY x 184 DAYS/MISSION x .003067 TOT.VOL/CYCLE (FT^3) = (.00227) (.080) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
-N/A-				
Σ①			Σ④	

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x ____ TOTAL LOST/CYCLE (Σ ④) = ____ (LB) + ____ (Σ ①) = ____ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Vacuum Collection

APPLIANCE CONCEPT NO./TITLE 3/Portable Vacuum/Space Venting

INDEX NO. 3.2.2.3 REF. NO. 1022

DESCRIPTION The portable vacuum/space venting concept uses a vacuum unit vented to space. A maximum 14.7 psi delta pressure is available, however the filter required will reduce the possible suction at the pickup nozzle. The concept was tried on Apollo, but did not provide enough suction. Proper design of the hose and penetration in the vehicle shell can make this unit operational. The collection bag used in concepts 1 and 2 serves as the filter and refuse trap. The flow used was based on the concept 1; 10 CFM. Venting overboard is allowed, since the vented gas is filterd and clean.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/PORTABLE VACUUM/SPACE VENTING INDEX NUMBER 3.2.2.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(7)
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/ PORTABLE VACUUM/SPACE VENTING   INDEX NUMBER 3.2.2.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
VACUUM UNIT (1.20)		
(INCLUDES HOSES AND	7.0	.175
ATTACHMENTS)		
VACUUM CLEANER BAGS	.444	.080
TOTAL	3.37 (7.44) KG (LBS)	.077 (.255) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
VACUUM CLEANER BAGS	1	.017 (1.20)	.017	.003067 (1.20)	.003067

Σ③ .017 TOTAL WT/CYCLE (LB)   Σ⑤ .003067 TOTAL VOL CYCLE (FT^3)

TOTAL WT. MISSION = .142 CYCLES/DAY x 184 DAYS/MISSION x .017 TOT.WT/CYCLE (LB) = .201 (.444) KG (LB)

TOTAL VOL MISSION = .142 CYCLES/DAY x DAYS/MISSION x .003067 TOT.VOL/CYCLE (FT^3) = .00227 (.080) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
OXYGEN	1.37	N/A	N/A	1.37

Σ① 1.37   Σ④ 1.37

TOTAL WT. MISSION = 5 CYCLE/DAY x 184 DAYS/MISSION x 1.37 TOTAL LOST/CYCLE (Σ④) = 1260 (LB) + N/A (Σ①) = 571.2 (1260) KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.2 Refuse Management

APPLIANCE FUNCTION 3.2.4 Refuse Processing

NUMBER OF CONCEPTS CONSIDERED 12

ASSUMPTIONS

1. The refuse processing of refuse utilizes, compaction, shredding, incineration, and decomposition methods for processing. The shredders were combined with other processing concepts,such as compactorsto increase the efficiency of refuse volume reduction. Shredders were not considered as a separate method for trash processing since it actually increases the refuse volume and requires the aid of a compactor or incinerator for reducing refuse volume.
2. The refuse mix used for the compressible refuse volume is summarized in Table C2-6.
3. The incineration and decomposition concepts 9 through 12 were considered only with shredders. Reference data indicates shredders are necessary to achieve efficient performance of these units.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.2.9 **** REFUSE PROCESSING (SPACE STATION)

CONCEPT NO.	USAGE TIME: USES/DAY / HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS: TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS: COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS: PK PWR AC / DC -WATTS-	AVG PWR AC / DC -WATTS-	WT/VOL REQMTS: WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST: AVAIL (**)	INDEX (***)	RESUPPLY: WEIGHT -KG- (LBS)
1	5.200	1	.0000	.00	1810.0	21.1	0.	0.	.0	.0	55.9	.21	2	30	21.5
	.017		(.0000)	.00	(35.0)	(70.0)	(0.)	(0.)	10.0	10.0	(123.2)	(7.41)			(47.3)
2	5.200	2	.0163	.00	.0	.0	0.	0.	.0	.0	87.8	.31	2	30	52.6
	.017		(.0360)	.00	(.0)	(.0)	(0.)	(0.)	10.0	10.0	(193.5)	(10.95)			(116.1)
3	5.200						0.	50.	745.0	745.0	58.2	.21	2	30	21.5
	.017						(0.)	(169.)	.0	.0	(128.2)	(7.40)			(47.3)
4	24.300						0.	0.	.0	.0	33.7	.53	2	50	21.5
	.017						(0.)	(0.)	.0	.0	(74.4)	(18.81)			(47.3)
5	5.200	1	.0000	.00	1810.0	21.1	0.	149.	745.0	745.0	89.9	.25	2	40	21.5
	.017		(.0000)	.00	(35.0)	(70.0)	(0.)	(509.)	10.0	10.0	(198.2)	(9.00)			(47.3)
6	5.200	2	.0163	.00	.0	.0	0.	149.	745.0	745.0	105.5	.25	2	40	36.7
	.017		(.0360)	.00	(.0)	(.0)	(0.)	(509.)	10.0	.0	(232.5)	(9.00)			(80.9)
7	5.200						0.	199.	1490.0	.0	92.2	.25	2	40	21.5
	.017						(0.)	(678.)	746.0	.0	(203.2)	(9.00)			(47.3)
8	24.300						0.	149.	745.0	745.0	67.8	.58	2	40	21.5
	.017						(0.)	(509.)	.0	.0	(149.4)	(20.40)			(47.3)
9	2.000	1	.0000	9.44	.0	.0	0.	1394.	1400.0	.0	122.8	2.14	3	40	41.6
	12.000		(.0000)	20.00	(.0)	(.0)	(0.)	(4760.)	.0	.0	(270.7)	(75.40)			(91.7)
10	2.000	3	.5820	.00	.0	21.1	0.	999.	1000.0	.0	341.4	2.05	3	65	251.5
	12.000		(1.2830)	.00	(.0)	(70.0)	(0.)	(3410.)	.0	.0	(752.7)	(72.50)			(554.[illegible])
11	2.000	3	.1706	.00	.0	21.1	0.	1394.	1400.0	.0	189.8	1.62	3	70	103.1
	12.000		(.3760)	.00	(.0)	(70.0)	(0.)	(4760.)	.0	.0	(418.4)	(57.20)			(227.4)
12	2.000	3	.2291	.00	62058.0	21.1	0.	899.	900.0	.0	346.0	2.44	3	75	124.4
	12.000		(.5050)	.00	(1200.0)	(70.0)	(0.)	(3070.)	.0	.0	(806.8)	(86.20)			(274.2)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	COMPACTOR-AIR PRESSURE
2 -	COMPACTOR-VACUUM
3 -	COMPACTOR-MOTOR
4 -	COMPACTOR-MANUAL
5 -	COMPACTOR-AIR PRESSURE W/SHREDDER
6 -	COMPACTOR-VACUUM W/SHREDDER
7 -	COMPACTOR-MOTOR W/SHREDDER
8 -	COMPACTOR-MANUAL W/SHREDDER
9 -	INTEGRATED VACUUM DECOMPOSITION/SHREDDER
10 -	FLUSH FLOW OXYGEN INCINERATION/SHREDDER
11 -	PYROLYSIS/BATCH INCINERATION/SHREDDER
12 -	WET OXIDIZATION/ SHREDDER

(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST), KG/HR (LB/HR)
3 - OXYGEN (LOST), KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST), KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED), KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED), KG/HR (LB/HR)

(**)AVAILABLE
(1) AVAILABLE
(2) STATE OF THE ART
(3) SOME DEVELOPMENT REQUIRED
(4) EXTENSIVE DEV. REQUIRED

(***)COST INDICATOR
0-25%
25-50%
50-75%
75-100%

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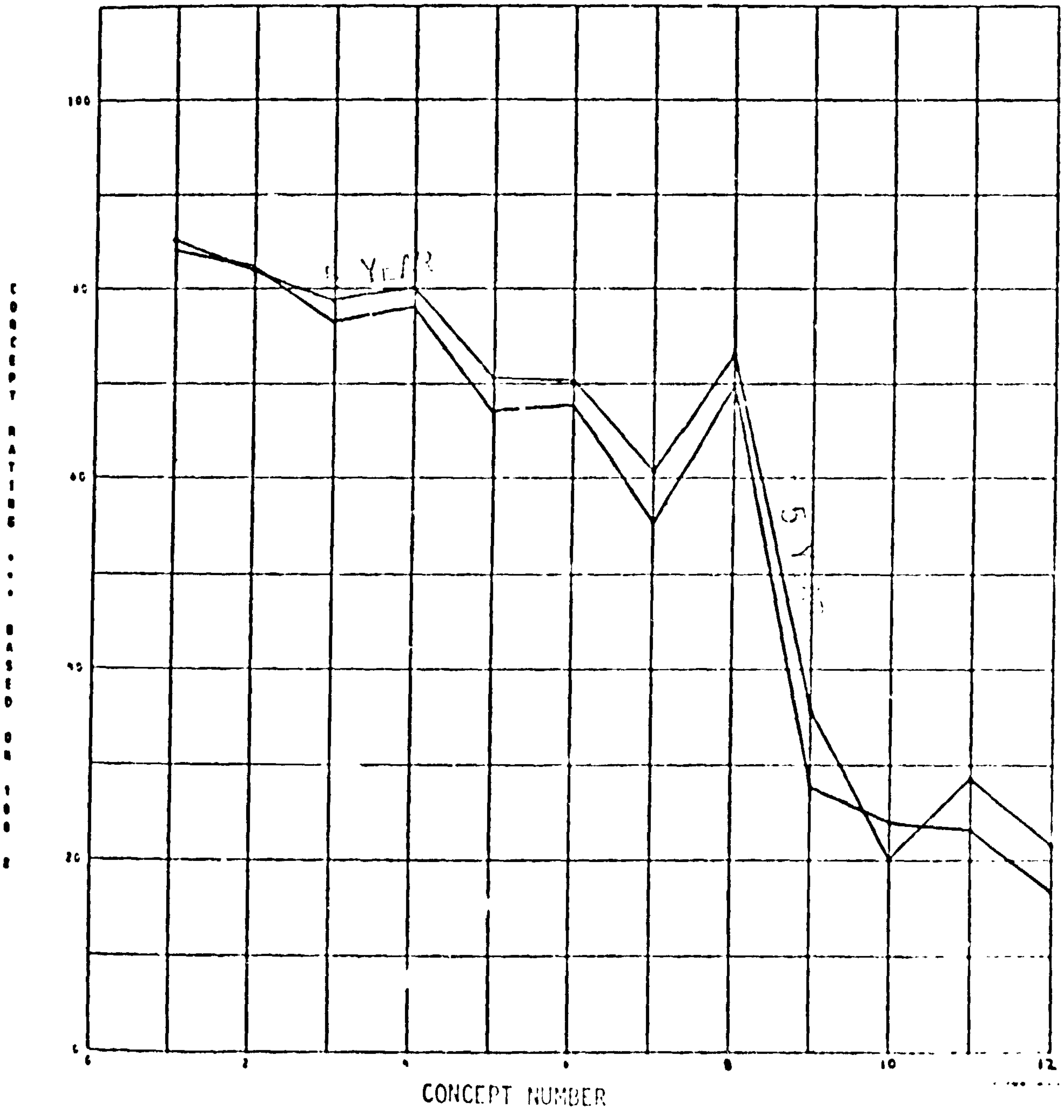
APPLIANCE CONCEPT NO.		CONCEPT NAME
1	-	COMPACTOR-AIR PRESSURE
2	-	COMPACTOR-VACUUM
3	-	COMPACTOR-MOTOR
4	-	COMPACTOR-MANUAL
5	-	COMPACTOR-AIR PRESSURE W/SHREDDER
6	-	COMPACTOR-VACUUM W/SHREDDER
7	-	COMPACTOR-MOTOR W/SHREDDER
8	-	COMPACTOR-MANUAL W/SHREDDER
9	-	INTEGRATED VACUUM DECOMPOSITION/SHREDDER
10	-	FLUSH FLOW OXYGEN INCINERATION/SHREDDER
11	-	PYROLYSIS/BATCH INCINERATION/SHREDDER
12	-	WET OXIDIZATION/ SHREDDER



Refuse Processing (Space Station) Concept Trade

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 14
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX . . . . . REFUSE PROCESSING (SPACE STATION)
(01/25/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
WEIGHT	74.400	806.80	15	12.71	11.40	12.62	13.62	11.32	10.68	11.22	12.22	9.97	1.01	7.22	.00
POWER	.00000	1.98.8	15	14.94	14.34	9.71	15.00	9.65	9.65	.00	9.71	5.05	7.89	5.05	8.60
VOLUME	7.4000	86.200	10	9.14	8.73	9.14	7.82	8.96	8.96	8.96	7.53	1.25	1.59	3.36	.00
THERMAL	.00000	609.28	15	15.00	15.00	14.47	15.00	13.40	13.40	12.86	13.40	.00	4.25	.00	5.33
RELIAB-Y	.17119	.99986	5	4.98	4.99	4.98	5.00	4.98	4.98	4.98	4.97	.30	.14	.00	.12
MAINTENC	.99999	1.00000	5	3.27	3.51	2.63	4.97	1.67	2.89	2.00	4.35	1.15	.33	.61	.00
SAFETY	1.0000	2.0000	5	2.50	2.50	2.50	.00	.00	.00	.00	.00	2.50	2.50	2.50	.00
DEV COST	30.000	75.000	15	9.00	9.00	9.00	5.00	7.00	7.00	7.00	7.00	3.00	2.00	1.00	.00
REC COST	47.300	554.42	15	13.72	11.66	13.72	13.72	13.72	12.91	13.72	13.72	12.52	.00	8.85	7.55
TOTAL PT	.00000	100.00	100	85.26	81.94	78.76	80.13	70.68	70.36	60.74	73.00	35.74	20.22	28.60	21.63
RATING	.00000	100.00	100	85.26	81.94	78.76	80.13	70.68	70.36	60.74	73.00	35.74	20.22	28.60	21.63

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	85.26	81.94	78.76	80.13	70.68	70.36	60.74	73.00	35.74	20.22	28.60	21.63
WEIGHT	85.23	81.52	79.13	80.87	71.01	70.42	61.72	73.59	37.88	19.27	29.96	20.12
POWER	86.26	83.17	77.78	81.51	70.24	69.94	56.50	72.42	35.59	22.48	26.95	24.12
VOLUME	85.55	82.19	79.36	80.04	71.58	71.27	62.11	73.16	34.63	20.01	[illegible].84	20.60
THERMAL	86.29	83.20	79.99	81.51	71.98	71.68	62.48	74.14	33.24	20.79	26.60	22.60
RELIAB-Y	85.61	82.37	79.27	80.61	71.39	71.07	61.69	73.65	35.01	19.79	27.90	21.16
MAINTENC	84.78	81.65	78.12	80.60	69.77	70.05	60.23	73.34	35.42	20.13	28.20	21.10
SAFETY	84.40	81.16	78.06	78.17	68.96	68.64	59.26	71.22	36.09	20.94	29.12	21.10
DEV COST	83.50	80.41	77.45	76.86	69.01	68.71	59.76	71.16	34.64	19.74	27.07	20.12
REC COST	85.70	81.74	79.65	80.92	72.13	71.41	62.68	74.29	39.07	18.81	30.72	23.64

SENSITIVITY ANALYSIS

RATING FOR EACH ONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	85.26	81.94	78.76	80.13	70.68	70.36	60.74	73.00	35.74	20.22	28.60	21.63
WEIGHT	85.31	82.42	78.33	79.26	70.30	70.29	59.60	72.31	33.25	21.31	27.02	23.38
POWER	84.10	80.50	79.99	78.52	71.20	70.85	65.66	73.67	35.90	17.59	28.19	18.73
VOLUME	84.94	81.65	78.09	[illegible]	[illegible]	69.35	59.22	72.62	36.96	20.45	28.33	22.77
THERMAL	84.07	80.4[illegible]	77.33	[illegible]	[illegible]	68.82	59.71	71.66	39.64	19.55	30.92	20.50
RELIAB-Y	84.89	81.46	78.[illegible]	[illegible]	[illegible]	69.61	59.74	72.32	36.50	20.66	29.33	22.12
MAINTENC	85.77	82.23	[illegible]	79.[illegible]	[illegible]	70.68	61.27	72.64	36.07	20.31	29.02	22.18
SAFETY	86.17	82.75	[illegible]	82.18	[illegible].49	72.16	62.30	74.87	35.37	19.45	28.05	22.18
DEV COST	87.31	83.71	[illegible]	83.92	72.63	72.28	61.88	75.13	37.01	20.78	[illegible].38	23.38
REC COST	84.76	82.17	77.[illegible]	[illegible].21	69.00	69.14	58.25	71.50	31.87	21.86	26.14	19.28

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 14
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX . . . . . REFUSE PROCESSING (SPACE STATION)
(01/25/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
WEIGHT	74.400	806.80	15	12.71	11.40	12.62	13.62	11.32	10.68	11.22	12.22	9.97	1.01	7.22	.00
POWER	.00000	1498.8	15	14.94	14.94	9.71	15.00	9.65	9.65	.00	9.71	5.05	7.89	5.05	8.00
VOLUME	7.4000	86.200	10	9.14	8.73	9.14	7.82	8.96	8.96	8.96	7.63	1.25	1.59	3.36	.00
THERMAL	.00000	609.28	15	15.00	15.00	14.47	15.00	13.40	13.40	12.86	13.40	.00	4.25	.00	5.33
RELIAB-Y	.84031	.99999	5	4.99	4.99	4.99	5.00	4.99	4.99	4.99	4.99	.67	.34	.00	.00
MAINTENC	.99999	1.00000	5	3.27	3.51	2.63	4.97	1.67	2.89	2.00	4.35	1.15	.83	.61	.00
SAFETY	1.0000	2.0000	5	2.50	2.50	2.50	.00	.00	.00	.00	.00	2.50	2.50	2.50	.00
DEV COST	30.000	75.000	15	9.00	9.00	9.00	5.00	7.00	7.00	7.00	7.00	3.00	2.00	1.00	.00
TOTAL PT	.00000	85.000	85	71.55	70.08	65.05	66.41	56.97	57.56	47.03	59.29	23.59	20.41	19.75	14.21
RATING	.00000	100.00	100	84.18	82.45	76.53	78.13	67.03	67.71	55.33	69.76	27.75	24.01	23.24	16.72

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	84.18	82.45	76.53	78.13	67.03	67.71	55.33	69.76	27.75	24.01	23.24	16.72
WEIGHT	84.22	81.93	77.14	79.15	67.71	67.99	56.91	70.71	30.89	22.61	25.26	15.36
POWER	85.43	83.84	75.57	79.90	66.81	67.44	50.84	69.35	28.23	26.33	24.08	20.01
VOLUME	84.58	82.72	77.35	78.13	68.28	69.93	57.23	70.12	26.91	23.56	23.62	15.79
THERMAL	85.46	83.67	76.14	79.90	60.63	69.46	57.79	71.34	25.50	24.37	21.35	18.24
RELIAB-Y	84.62	82.95	77.19	78.75	67.96	68.63	56.60	70.61	27.34	23.52	22.57	16.40
MAINTENC	83.64	82.10	75.84	78.74	66.07	67.43	54.69	70.25	27.61	3.80	22.93	16.24
SAFETY	83.20	81.52	75.77	75.89	65.11	65.78	53.75	[illegible]7.76	23.39	[illegible]4.76	24.00	16.24
DEV COST	82.22	60.63	75.19	74.50	65.38	66.01	54.63	67.68	27.12	23.15	21.69	15.36

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10	11	12
NORMAL	84.18	82.45	76.53	78.13	67.03	67.71	55.3[illegible]	69.76	27.75	24.01	23.24	16.72
WEIGHT	84.12	83.07	75.79	76.90	66.21	67.38	53.44	68.62	24.01	25.69	20.83	18.33
POWER	82.68	60.79	77.67	76.01	67.29	68.04	60.68	70.24	27.18	21.25	22.23	12.78
VOLUME	83.72	82.15	75.60	78.12	65.62	66.35	53.19	69.34	28.70	24.52	22.59	17.76
THERMAL	82.64	60.75	74.60	76.01	64.[illegible]7	65.62	52.38	67.66	30.44	23.59	25.49	14.90
RELIAB-Y	63.70	81.72	75.82	77.46	66.04	6[illegible].74	53.98	68.65	28.19	24.54	23.94	17.05
MAINTENC	64.75	82.82	77.25	77.48	68.05	68.01	55.79	69.23	27.90	24.24	23.57	17.22
SAFETY	85.21	83.43	77.33	80.49	67.06	69.76	57.00	71.37	27.06	23.23	22.43	17.22
DEV COST	86.52	84.62	76.13	62.46	69.00	69.75	56.17	71.99	28.50	25.05	24.84	18.33

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APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.2.4-REFUSE PROCESSING

APPLIANCE TYPE \ COMPONENT TYPE	SOLENOID VALVE	ACCUMULATOR	FILTER	PRESSURE REGULATOR	CONTROLLER TIMER	RELIEF VALVE	ACTUATOR	PRESSURE SWITCH	MOTOR	ELECTRIC SWITCH	BLOWER	CHECK VALVES	HEATER	PUMP			NUMBER OF SAFETY CRITICAL ITEMS
NO.	3	4	9	11	19	25	27	28	1	10	8	22	17	2			
COMPACTOR/AIR PRESSURE	1	1	1	1	1	1	1	1	-	1	-	-	-	-			1
COMPACTOR/VACUUM PRESSURE	1	1	1	-	1	-	1	1	-	1	-	-	-	-			1
COMPACTOR/MOTOR	-	1	1	-	1	-	1	1	1	1	-	-	-	-			1
COMPACTOR/MANUAL	-	1	1	-	-	-	1	-	-	-	-	-	-	-			2
COMPACTOR/AIR PRESSURE & SHREDDER	1	1	1	1	1	1	1	1	1	2	-	-	-	-			2
COMPACTOR/VACUUM PRESSURE AND SHREDDER	1	1	1	-	1	-	1	1	-	2	-	-	-	-			2
COMPACTOR/MOTOR & SHREDDER	-	1	1	-	1	-	1	1	1	2	-	-	-	-			2
COMPACTOR/MANUAL & SHREDDER	-	1	1	-	-	-	1	-	-	1	-	-	-	-			2
INTEGRATED VACUUM DECOMPOSITION/ SHREDDER	10	2	2	-	1	-	-	-	-	-	2	2	2	-			1
FLUSH FLOW OXYGEN INCINERATION/ SHREDDER	14	2	2	-	1	-	-	-	-	-	2	2	2	-			1
PYROLYSIS/BATCH INCINERATION/ SHREDDER	14	3	2	1	1	-	-	-	-	-	2	2	2	-			1
WET OXIDATION/SHREDDER	13	3	2	1	1	-	-	-	1	-	1	-	2	1			2

SPACECRAFT Space Station

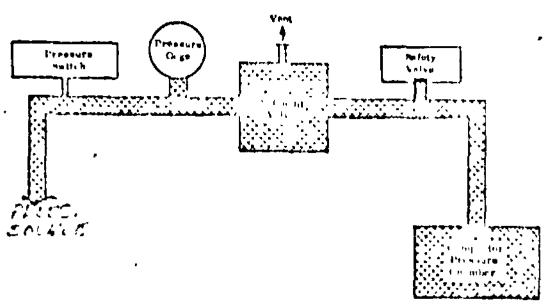
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

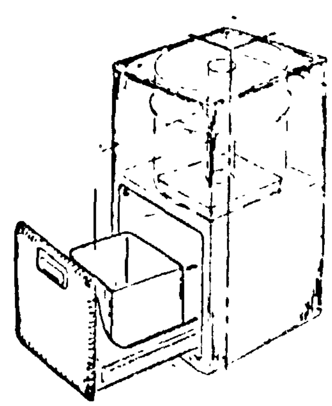
APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 1/Compactor-Air Pressure

INDEX NO. 3.2.4.1 REF. NO. 203,123,170,270

DESCRIPTION The compactor-air pressure concept uses air pressure against a piston for refuse compaction. The compactor is used for dry and moist compactible refuse. The unit provides a sterilant to the waste to prevent bacterial growth. The refuse is placed into a waste storage bag in the compactor. The compactor is actuated and compression of the refuse is accomplished using cabin air pressure of 40 psi. The piston used for the study was 9 inches square which results in 4000# of compaction pressure. The curve (see Fig. C2-1) from reference 123 shows 30 psi is more than adequate to attain a 0.2 compression ratio. The uncompressed refuse volume per day 2.45 FT^3/day, for Space Station and .947 FT^3/day for Shuttle, was divided by the compactor volume of .47FT^3 to determine the uses per day. Prior to tying the waste storage bag liner a sterilant capsule is placed into the bag. After tying, the capsule is broken releasing the sterilant gas.





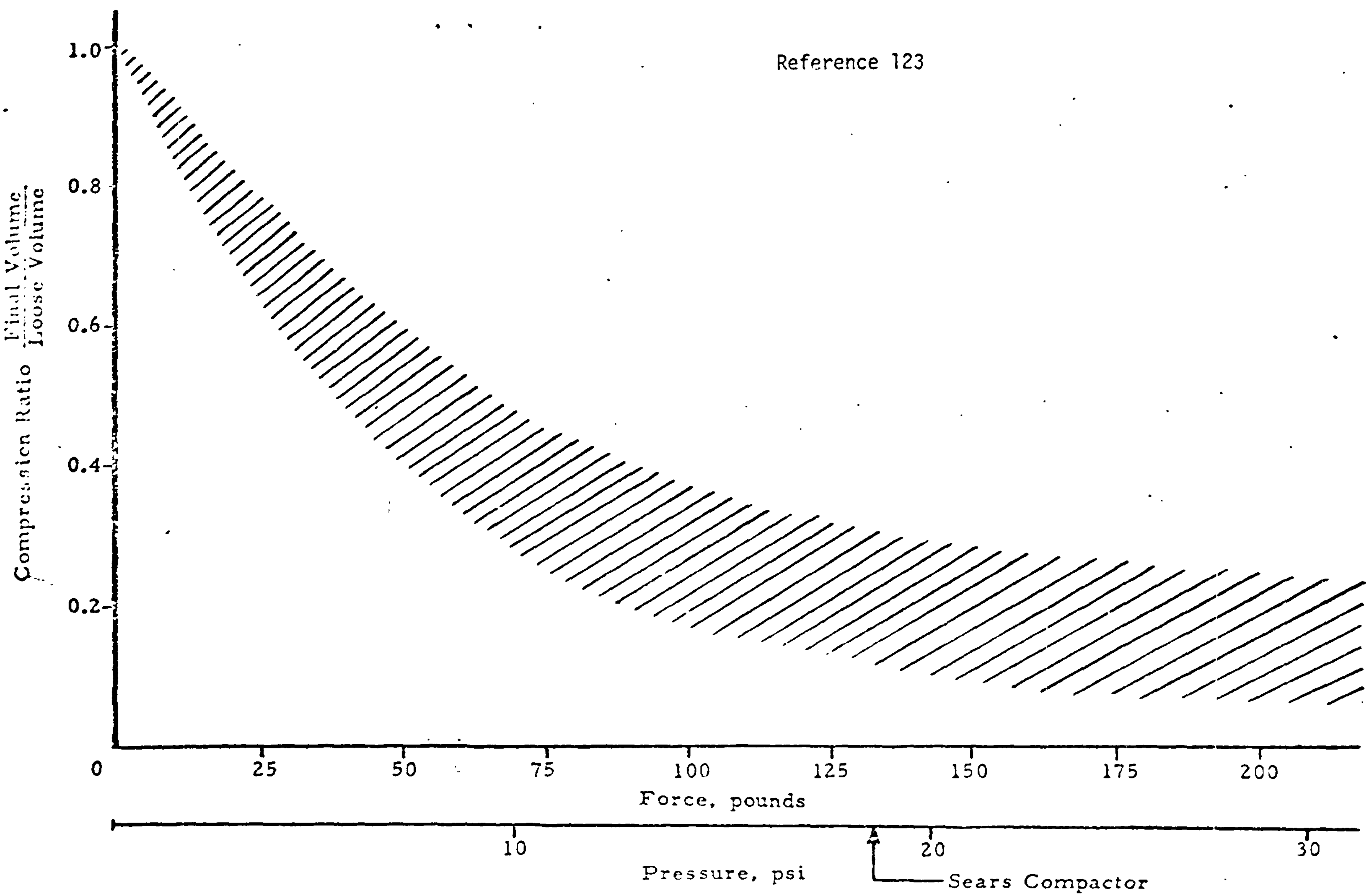


Figure C2-1. COMPOSITE COMPACTION DATA FOR TRASH MIXURES

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *1/COMPACTOR-AIR PRESSURE* INDEX NUMBER *3.2.4.1*

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)X(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)X(6)
VALVE	*.0167*	—	—	—	*8*	*8*	*.134*
CONTROLLER	*.0167*	—	—	—	*2*	*2*	*.033*
		MAXIMUM		TOTAL	*10* MAXIMUM		*.167* TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
VALVE/CONTROLLER	—	*NEG.*	*NEG.*	—
TOTAL	— WATT (BTU/HR)	*NEG.* WATT (BTU/HR)	*NEG.* WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A.					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER 3.2.4.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COMPACTOR [illegible]	75	2.8
[illegible]		
WASTE STORAGE BAGS	48.2	4.6
TOTAL	55.88 (123.2) KG (LBS)	.209 (7.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WASTE STORAGE BAG	.201 (1/9)	.25 (1/10)	.0504	.024 (1/0)	.00482

Σ③ .0504 TOTAL WT/CYCLE (LB) Σ⑤ .00482 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .0504 TOT.WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00482 TOT.VOL/CYCLE (FT^3) = .131 (4.6) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = ______ KG (LB)

SPACECRAFT Space Station

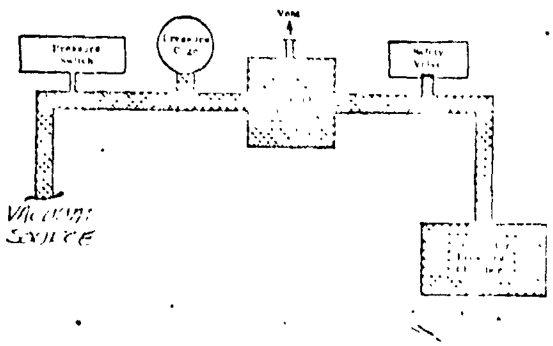
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

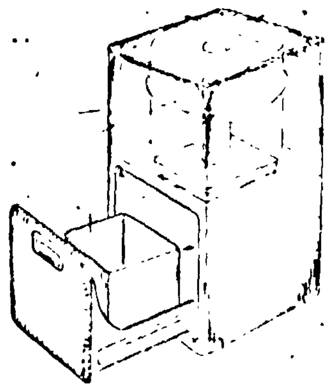
APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 2/Compactor-Vacuum

INDEX NO. 2.2.4.2 REF. NO. 203,123,170,270

DESCRIPTION The compactor-vacuum concept is identical to concept 1 with the exception that a vacuum is used to apply the compaction pressure. The maximum pressure available is 14.7 psi, therefore, using the same size compactor, the compression ration will be 0.35. The uses per day is the same as concept 1, however more bags will be used per mission due to the lower compression ratio. Cabin air is lost each time the unit is vented to vacuum. Venting overboard was allowed, since the cabin air is not contaminated.





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APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/COMPLETE VACUUM INDEX NUMBER 3.2.1.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	(3) AVERAGE (WATTS)	(4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	(6) AVERAGE (WATTS)	(7) DEMAND (WATT-HR/CYCLE) (1)x(6)
VALVE	.0167	—	—	—	8	8	.134
CONTROLLER	.0167	—	—	—	2	2	.033
		MAXIMUM		TOTAL	10 MAXIMUM		.167 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
VALVE/CONTROLLER	—	NEG	NEG	—
TOTAL	— WATT (BTU/HR)	NEG WATT (BTU/HR)	NEG WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
[illegible]	75	2.8
[illegible]		
[illegible]	84.2	8.09
TOTAL	72.21 (158.2) KG (LBS)	.305 (10.9) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
WASTE [illegible] BAGS	.352	.25 (17)	.088	.027 (17)	.00945
			Σ③ .088 TOTAL WT/CYCLE (LB)		Σ⑤ .00945 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .088 TOTAL WT/CYCLE (LB) = 38.19 (84.2) KG (LB)

TOTAL VOL MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00945 TOTAL VOL/CYCLE (FT³) = .229 (8.09) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
CABIN AIR	.036	N/A	N/A	.036
	Σ① .036			Σ④ .036

TOTAL WT. MISSION = 5.2 CYCLE/DAY x 184 DAYS/MISSION x .036 TOTAL LOST/CYCLE (Σ④) = 34.4 (LB) + N/A (Σ①) = 15.6 (34.4) KG (LB)

SPACECRAFT Space Station

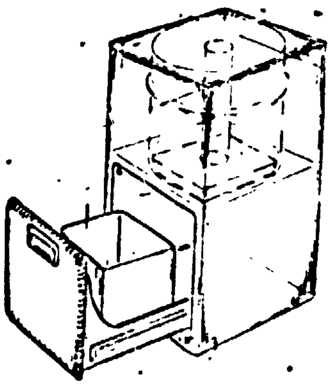
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 3/Compactor-Motor

INDEX NO. 3.2.4.3 REF. NO. 203,123,170,270,202

DESCRIPTION The compactor-motor concept is identical to concept 1 with the exception that a motor is used to apply the compaction pressure. The motor is a linear actuator. The compactor actuation and loading was assumed to be identical to concept 1.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/COMPACTOR-MOTOR

INDEX NUMBER 3.2.4.3

ELECTRICAL POWER REQUIREMENTS

		AC POWER				DC POWER		
COMPONENT (REF)	(1) USE TIME CYCLE (HR)	(2) PEAK (WATTS)	(3) AVERAGE (WATTS)	(4) DEMAND (WATT-HR/CYCLE) (1)x(3)	(5) PEAK (WATTS)	(6) AVERAGE (WATTS)	(7) DEMAND (WATT-HR/CYCLE) (1)x(7)
MOTOR (282)	.0167	745	745	12.4	—	—	—
		745 MAXIMUM		12.4 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTOR	—	169.5	169.5	—
TOTAL	— WATT (BTU/HR)	49.7 (169.5) WATT (BTU/HR)	49.7 (169.5) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/Compactor motor

INDEX NUMBER 3.2.4.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Compactor (includes (170) SkyKill ampuls)	80	2.8
Waste storage bags	48.2	4.6
TOTAL	58.15 (128.2) KG (LBS)	.209 (7.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Waste storage bags	.201 (170)	.25 (170)	.0504	.024 (170)	.00482

Σ③ .0504 TOTAL WT/CYCLE (LB) Σ⑤ .00482 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .0504 TOT.WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00482 TOT.VOL/CYCLE (FT^3) = .131 (4.6) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
-N/A-				

Σ① ____ Σ④ ____

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ____ (LB) + ____ (Σ①) = ____ KG (LB)

SPACECRAFT Space Station

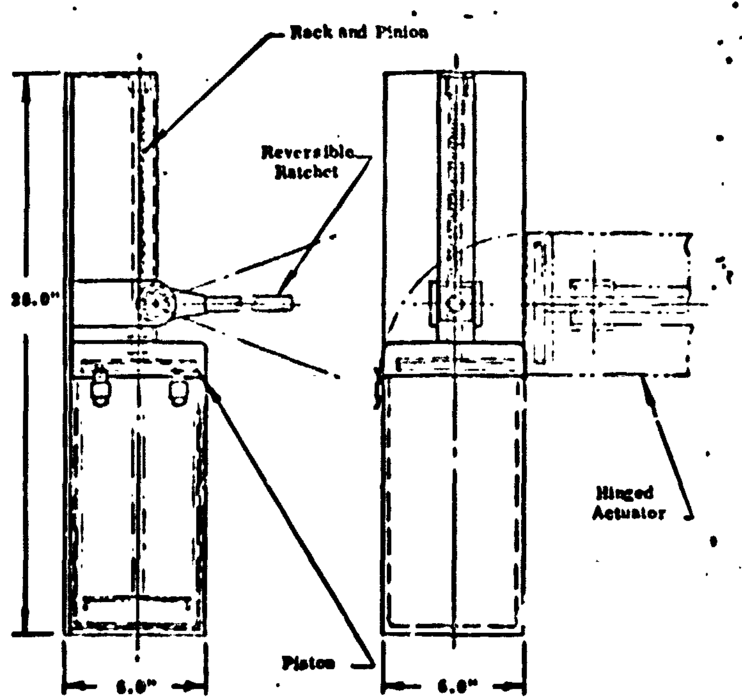
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 4/Compactor-Manual

INDEX NO. 3.2.4.4 REF. NO. 160

DESCRIPTION: The compactor-manual concept is a manually actuated piston refuse compactor. The manual compactor cannot be the same size as concepts 1 through 3 because of the crewman physical limitations. The concept requires a large amount of crew time because of its smaller size increases its uses per day. The design utilizes a piston actuated by a lever which contains a double acting ratchet mechanism and a pinion gear which drives a gear rack shaft. By an up and down pumping action, the piston compacts the refuse. The same waste bag weight and volume is assumed for this unit since it processed the same volume of refuse as concepts 1 through 3.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 4/COMPACTOR - MANUAL INDEX NUMBER 3.2.1.4

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 4/COMPACTOR-MANUAL INDEX NUMBER 3.2.44

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COMPACTOR (INCLUDES (160) STERILANT AMPULS.)	26.2	14.2
WASTE STORAGE BAGS	48.2	4.6
TOTAL	33.75 (74.4) KG (LBS)	.532 (18.8) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WASTE STORAGE BAGS	.144	.0747	.0108	.00714	.00103

Σ③ .0108 TOTAL WT/CYCLE (LB) Σ⑤ .00103 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 24.3 CYCLES/DAY x 184 DAYS/MISSION x .0108 TOT.WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL MISSION = 24.3 CYCLES/DAY x 184 DAYS/MISSION x .00103 TOT.VOL/CYCLE (FT^3) = .131 (9.6) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ ④) = ______ (LB) + ______ (Σ ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 5/Compactor-Air Pressure w/Shredder

INDEX NO. 3.2.4.5 REF. NO. 203, 123, 170, 270, 202

DESCRIPTION: The compactor-air pressure with shredder is identical to concept 1 with the addition of a shredder. Reference 202 stated that dry waste can be compacted more efficiently if previously shredded. Reference 123, see curve at front of appliance function section, test data does not indicate shredding will accommodate any change in compression ratio since the curve becomes asymptotic to the force line for this compactor. However, the shredder was added to the air pressure compactor for the purpose of comparison. The shredder is a commercial type used to shred paper and could with modification handle moist shredable waste. The units were based on one use for each of 3 meals, 2 scheduled cleanups, 3 spills (unscheduled), and 3 miscellaneous for paper, books, etc. The time per use was assumed to be 3 minutes. Shredding of solid wastes was not considered by this concept.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 5/COMPACTOR - AIR PRESSURE W/SHREDDER INDEX NUMBER 3.2.4.5

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVE	.0167	—	—	—	8	8	.134
CONTROLLER	.0167	—	—	—	2	2	.033
SHREDDER MOTOR	.05	745	745	37.25	—	—	—
		745 MAXIMUM		37.25 TOTAL	10 MAXIMUM		.167 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
VALVE/CONTROLLER	—	NEG.	NEG.	—
SHREDDER MOTOR	—	509	509	—
TOTAL	WATT (BTU/HR)	149.3 (509) WATT (BTU/HR)	149.3 (509) WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 5/COMPACTOR-AIR PRESSURE W/SHREDDER INDEX NUMBER 3.2.4.5

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COMPACTOR (INCLUDES (170) STERILANT AMPULS)	75.0	2.8
SHREDDER	75.0	1.6
WASTE STORAGE BAGS	48.2	4.6
TOTAL	89.9 (198.2) KG (LBS)	.255 (9.0) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WASTE STORAGE BAGS	.201 (170)	.25 (170)	.0504	.024 (170)	.00482

Σ③ .0504 TOTAL WT/CYCLE (LB) Σ⑤ .00482 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .0504 TOT.WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00482 TOT.VOL/CYCLE (FT^3) = .131 (4.6) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 6/Compactor-Vacuum w/Shredder

INDEX NO. 3.2.4.6 REF. NO. 203,123,170, 270, 202

DESCRIPTION : The compactor-vacuum with shredder concept is identical to concept 2 with the addition of the shredder described in concept 5. The compression ratio was changed from 0.35 to 0.2 based on the increase of compacting efficiency using a shredder.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 6/COMPACTOR-VACUUM W/SHREDDER INDEX NUMBER 3.2.4.6

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVE	.0167	—	—	—	8	8	.134
CONTROLLER	.0167	—	—	—	2	2	.033
SHREDDER MOTOR	.05	745	745	37.25	—	—	—
		745 MAXIMUM		37.25 TOTAL	10 MAXIMUM		.167 TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
VALVE/CONTROLLER	—	NEG.	NEG.	—
SHREDDER MOTOR	—	509	509	—
TOTAL	— WATT (BTU/HR)	149.3(509) WATT (BTU/HR)	149.3(509) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 6/COMPACTOR-VACUUM W/SHREDDER INDEX NUMBER 3.2.4.6

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
COMPACTOR (INCLUDES (170) STERILANT AMPULS)	75	2.8
SHREDDER	75	1.6
WASTE STORAGE BAGS	48.2	4.6
TOTAL	89.9 (198.2) KG (LBS)	.255 (9.0) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
WASTE STORAGE BAGS	.201 (170)	.25 (170)	.0504	.024 (170)	.00482
			Σ③ .0504 TOTAL WT/CYCLE (LB)		Σ⑤ .00482 TOTAL VOL/CYCLE (FT³)

TOTAL WT./MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .0504 TOT.WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL./MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00482 TOT.VOL/CYCLE (FT³) = .131 (4.6) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				
	Σ①			Σ④

TOTAL WT./MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 7/Compactor-Motor w/Shredder

INDEX NO. 3.2.4.7 REF. NO. 203, 123, 170, 270, 202

DESCRIPTION: The compactor-motor w/shredder concept is identical to concept 3 with the addition of the shredder described in concept 5.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 7/COMPACTOR-MOTOR W/SHREDDER INDEX NUMBER 3.2.4.7

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
MOTOR	.0167	745	745	12.4	—	—	—
SHREDDER MOTOR	.05	745	745	37.25			
		1490 MAXIMUM		49.65 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTOR	—	169.5	169.5	—
SHREDDER MOTOR	—	509	509.0	—
TOTAL	— WATT (BTU/HR)	199.0(678.5) WATT (BTU/HR)	199.0(678.5) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 7/COMPACTOR - MOTOR W/SHREDDER INDEX NUMBER 3.2.4.7

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
COMPACTOR (INCLUDES STERILANT AMPULES)	(170)	80	2.8
SHREDDER		75	1.6
WASTE STORAGE BAGS		48.2	4.6
TOTAL		92.17 (203.2) KG (LBS)	.255 (9.0) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ① x ② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ① x ④ (FT^3)
WASTE STORAGE BAGS	.201 (170)	.25 (170)	.0504	.024 (170)	.00482
			Σ③ .0504 TOTAL WT/CYCLE (LB)		Σ⑤ .00482 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .0504 TOT. WT/CYCLE (LB) = 21.87 (48.2) KG (LB)

TOTAL VOL MISSION = 5.2 CYCLES/DAY x 184 DAYS/MISSION x .00482 TOT. VOL/CYCLE (FT^3) = .131 (4.6) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ① x ② (LB)	④ AMT LOST/CYCLE ① - ③ (LB)
N/A				
	Σ①		Σ④	

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE (Σ ④) = ____ (LB) + ____ (Σ ①) = ____ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 8/Compactor-Manual w/Shredder

INDEX NO. 3.2.4.8 REF. NO. 160, 202

DESCRIPTION: The compactor-manual with shredder is identical to concept 4 with the addition of the shredder described in concept 5.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 8/COMPACTOR-MANUAL W/SHREDDER INDEX NUMBER 3.2.4.8

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
SHREDDER MOTOR	.05	745	745	37.25	—	—	—
		745 MAXIMUM		37.25 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
SHREDDER MOTOR	—	509	509	—
TOTAL	— WATT (BTU/HR)	149.3(509) WATT (BTU/HR)	149.3(509) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 8/COMPACTOR-MANUAL W/SHREDDER INDEX NUMBER 3.2.4.8

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COMPACTOR (INCLUDES (160) STERILANT AMPULES)	26.2	14.2
SHREDDER	75	1.6
WASTE STORAGE BAGS	48	4.6
TOTAL	67.77 (149.4) KG (LBS)	.578 (20.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
WASTE STORAGE BAGS	.144	.0747	.0108	.00714	.00103

Σ③ .0108 TOTAL WT/CYCLE (LB) Σ⑤ .00103 TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = 24.3 CYCLES/DAY x 184 DAYS/MISSION x .0108 TOT WT/CYCLE (LB) = [21.87 (48.2)] KG (LB)

TOTAL VOL/MISSION = 24.3 CYCLES/DAY x 184 DAYS/MISSION x .00103 TOT.VOL/CYCLE (FT^3) = [.131 (4.6)] M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① Σ④

TOTAL WT./MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = (LB) + (Σ①) = KG (LB)

SPACECRAFT Space Station

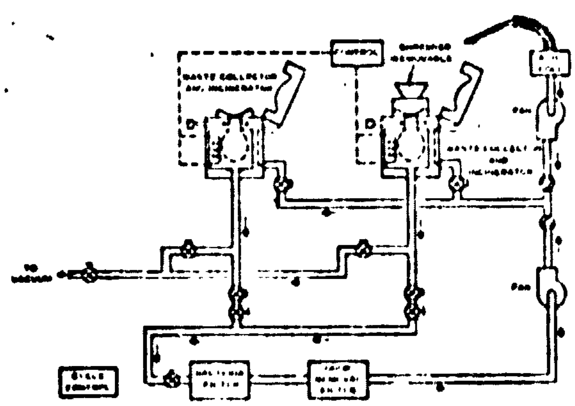
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 9/Integrated Vacuum Decomposition/Shredder

INDEX NO. 3.2.4.9 REF. NO. 100, 250

DESCRIPTION: The integrated vacuum decomposition/shredder concept utilizes vacuum and high temperature to decompose the refuse materials into gaseous products which can be exhausted to vacuum. The shredder is required to expose more refuse area to increase the decomposition efficiency. The chamber requires cool-down period. The process does not require oxygen; however, requires power to sustain the chemical process for 21 hours. Two units were assumed based on the refuse volume and the 12-hour cooldown time required by the unit (one unit can be used once per day). Incinerable collection bags with a hydrophobic patch were used to eliminate the maintenance and microbiological problems of filter replacement, since clogging is not anticipated with collection bags which are replaced every 24 hours. The residual ash was not considered as a concept penalty.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 9/INTEGRATED VACUUM DECOMPOSITION/SHROUDER INDEX NUMBER 3. .49

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①X⑦
COLLECTION UNIT (170)	12	1400			—	—	—
		1400 MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
COLLECTION UNIT (100)	—	4760	4760	—
TOTAL	— WATT (BTU/HR)	1396 (4760) WATT (BTU/HR)	1396 (4760) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
-N/A-					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 9/INTEGRATED VACUUM DECOMPOSITION/SHREDDER INDEX NUMBER 3.2.4.9

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTION UNIT (100)	177	63.5
COLLECTION BAGS	93.7	11.9
TOTAL	122.8 (270.7) KG (LBS)	2.13 (75.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
COLLECTION BAGS	1 (100)	.255 (100)	.255	.0323 (100)	.0323
		Σ③	.255 TOTAL WT/CYCLE (LB)	Σ⑤	.0323 TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .255 TOT. WT/CYCLE (LB) = 42.5 (93.7) KG (LB)

TOTAL VOL/MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0323 TOT. VOL/CYCLE (FT^3) = .337 (11.9) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
-N/A-				
Σ①			Σ④	

TOTAL WT./MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE (Σ ④) = ____ (LB) + ____ (Σ ①) = ____ KG (LB)

SPACECRAFT Space Station

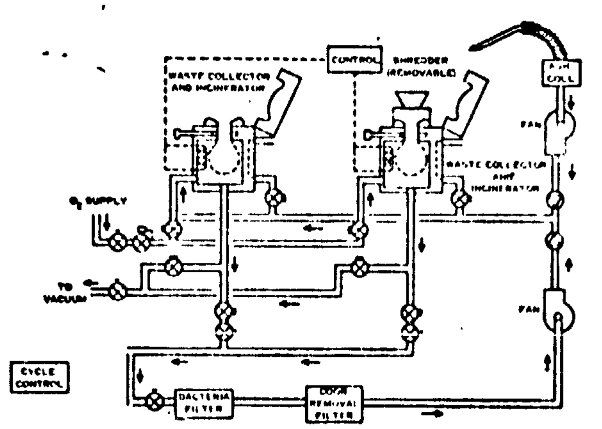
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 10/Flush Flow Oxygen Incineration/Shredder

INDEX NO. 3.2.4.10 REF. NO. 100, 250

DESCRIPTION: The flush flow oxygen incineration/shredder concept utilizes a continuous oxygen flow to the collection chamber for the 12 hours required for incineration. The refuse is collected/shredded and inserted into the chamber, sealed in the chamber (no vent to vacuum), heat is applied for a specified time period. The resulting sterilized/vaporized gas and vapors are exhaust to space. The valve is left open and heat is applied to bring the incineration temperature to 1000°F, while a controlled flow of oxygen is continuously supplied to the chamber. The incineration process takes approximately 12 hours with 97 to 99 percent reduction in refuse volume. Twelve hours are allowed for cooldown requiring two units per vehicle. The collection bags described in concept 9 are also used for this concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 10/FLUSH FLOW OXYGEN INCINERATION/SHREDDER INDEX NUMBER 3.2.4.10

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
COLLECTOR UNIT	(100)	12	1000			—	—	—
			1000 MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
COLLECTOR UNIT (100)	—	3410	3410	—
TOTAL	— WATT (BTU/HR)	1000 (3410) WATT (BTU/HR)	1000 (3410) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)	/	KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 10/FLUSH FLOW OXYGEN INCINERATION/SHREDDER INDEX NUMBER 3.2.4.10

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTION UNIT	(100)	186	61.6
COLLECTION BAGS		93.7	11.9
TOTAL		126.9 (279.7) KG (LBS)	2.05 (72.5) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
COLLECTION BAGS	1 (100)	.255 (100)	.255	.0323 (100)	.0323

Σ③ .255 TOTAL WT/CYCLE (LB)   Σ⑤ .0323 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .255 TOT.WT/CYCLE (LB) = 42.5 (93.7) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0323 TOT.VOL/CYCLE (FT^3) = .337 (11.9) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
OXYGEN	1.283	N/A	N/A	1.283

Σ① 1.283   Σ④ 1.283

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x 1.283 TOTAL LOST/CYCLE (Σ④) = 472 (LB) + 1.28 (Σ①) = 214.7 (473.3) KG (LB)

SPACECRAFT Space Station

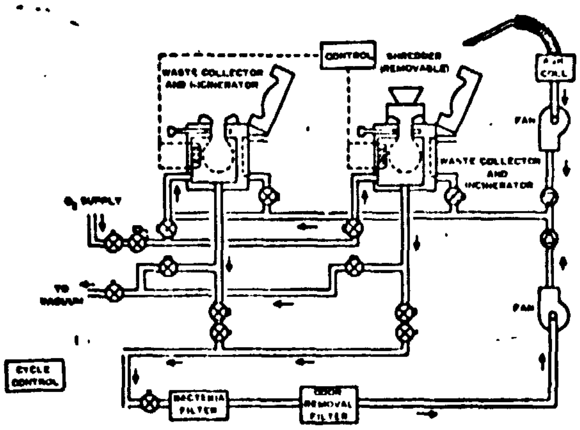
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 11/Pyrolysis/Batch Incineration/Shredder

INDEX NO. 3.2.4.11 REF. NO. 100, 250

DESCRIPTION: The pyrolysis/batch incineration/shredder concept utilizes a three-step process to minimize oxygen consumables. The shredded refuse is heated to 250°F and held at this temperature for 30 minutes to ensure sterilization. The vent valve is then opened and the water is flashed to space as a vapor. The chamber is then heated to 1200°F, with the vacuum valve remaining open, and the wastes are pyrolytically decomposed (vacuum decomposition) and the gases are vented to space. At the end of the pyrolysis process, the vent valve is closed, the chamber is charged with oxygen, and several batch incinerations are performed. The batch incineration step also reduces the ash residue from 12 to 2 percent of the total wastes processed. After final venting to space, the chamber cooldown takes 12 hours. The pyrolysis/batch incineration process is identical to the schematic shown for concept 10. The pyrolysis/batch incineration takes 12 hours. The collection bags described in concept 9 are also used for this concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT II/PYROLYSIS/BATCH INCINERATION/SHREDDER INDEX NUMBER 3.2.4.11

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	③ AVERAGE (WATTS)	④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	⑥ AVERAGE (WATTS)	⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
COLLECTION UNIT (100)	12	1400					
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
COLLECTION UNIT (100)	—	4760	4760	—
TOTAL	—	1396 (4760)	1396 (4760)	—
	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 11/PYROLYSIS/BATCH INCINERATION/SHREDDER INDEX NUMBER 3.2.4.11

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTION UNIT (100)	186	45.3
COLLECTION BAGS	93.7	11.9
TOTAL	126.9 (279.7) KG (LBS)	1.62 (57.2) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
COLLECTION BAGS	1 (100)	.255 (100)	.255	.0323 (100)	.0323

Σ③ .255 TOTAL WT/CYCLE (LB)   Σ⑤ .0323 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .255 TOT.WT/CYCLE (LB) = 42.5 (93.7) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0323 TOT.VOL/CYCLE (FT^3) = .337 (11.9) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
OXYGEN	.376	N/A	N/A	.376

Σ① .376   Σ④ .376

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .376 TOTAL LOST/CYCLE Σ④ = 138.3 (LB) + .374 Σ① = 62.9 (138.7) KG (LB)

SPACECRAFT Space Station

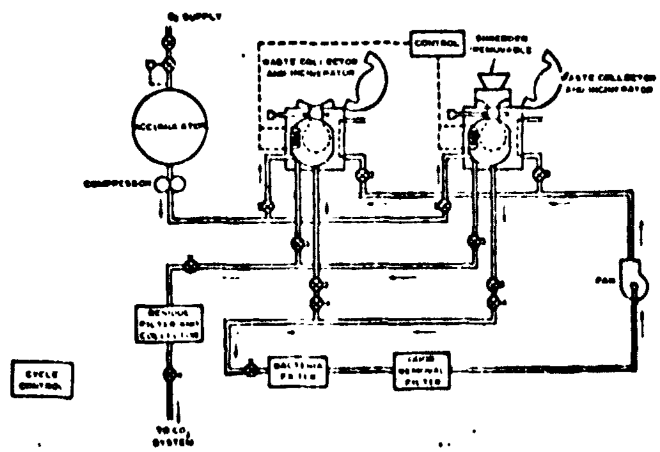
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Processing

APPLIANCE CONCEPT NO./TITLE 12/Wet Oxidization/Shredder

INDEX NO. 3.2.4.12 REF. NO. 100, 250

DESCRIPTION: The wet oxidization/shredder concept is a moderate temperature, high pressure catalytic process. The system employs an insulated chamber similar to the incineration and decomposition concepts. Shredded refuse treatment is accomplished by charging the chamber with 500 psia oxygen at ambient temperature and applying heat to bring the chamber up to oxidation temperature. The final pressure and temperature are approximately 1750 psia and 500^{o}F. The advantage of the wet oxidation process is the production of water which can be processed and reused in the spacecraft. The system requires a high pressure oxygen source, assumed in this study as a compressor. A stirrer would enhance the wet oxidation process, but was not considered in this study due to lack of engineering data. Based on two data sources, the process was assumed to take 21 hours, most of which is cooldown time (10½ to 6 hours). The collection bags described in concept 9 are also used for this concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 12/WET OXIDIZATION/SHREDDER INDEX NUMBER 3.2.4.12

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
COLLECTION UNIT	(100)	4	900			—	—	—
			900 MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
COLLECTION UNIT (100)	—	3070	3070	—
TOTAL	— WATT (BTU/HR)	900 (3070) WATT (BTU/HR)	900 (3070) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 12/WET OXIDIZATION/SHREDDER INDEX NUMBER 3.2.4.12

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
COLLECTION UNIT (100)	526.5	74.3
COLLECTION BAGS	93.7	11.9
TOTAL	281.3 (620.2) KG (LBS)	2.44 (86.2) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
COLLECTION BAGS	1 (100)	.255 (100)	.255	.0323 (100)	.0323

Σ③ .255 TOTAL WT/CYCLE (LB) Σ⑤ .0323 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .255 TOT.WT/CYCLE (LB) = 42.5 (93.7) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0323 TOT.VOL/CYCLE (FT^3) = .337 (11.9) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
OXYGEN	.505	N/A	N/A	.505

Σ① .505 Σ④ .505

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .505 TOTAL LOST/CYCLE (Σ④) = 185.8 (LB) + .505 (Σ①) = 84.5 (186.4) KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.2 Refuse Management

APPLIANCE FUNCTION 3.2.5 Refuse Disposal

NUMBER OF CONCEPTS CONSIDERED 3

ASSUMPTIONS

(1) Refuse disposal includes concepts most likely to be used on near term spacecraft. The concepts consider vacuum storage, static onboard storage, and jettison to earth for aerodynamic incineration. Disposal of refuse using rockets to the sun was not used, since radioactive wastes were not considered by the study.

(2) The refuse volume and weight is based on the tabulation on Table C2-6.

(3) The uncompressed volume of trash was used to size all of the concepts.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX No. 3.2.5 **** REFUSE DISPOSAL (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	1.000 .032	2	.3039 .67001(	.00 .00)	.0 .0)	.0 .0)	0. (0.)	0. (0.)	.0 .0	.0 .0	235.9 (520.0)	14.62 (507.00)	1	10	54.6 (120.3)
2	1.000 .032						0. (0.)	0. (0.)	.0 .0	.0 .0	44.3 (97.6)	14.57 (505.00)	1	10	.8 (1.9)
3	1.000 .001						0. (0.)	0. (0.)	.0 10.0	.0 .0	248.6 (548.0)	.73 (25.90)	2	35	191.1 (421.4)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 =	VACUUM STORAGE
2 =	STORAGE BIN/CONTAINER
3 =	SOLID PROPELLANT REFUSE ROCKET

(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST) , KG/HR (LB/HR)
3 - OXYGEN (LOST) , KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST) , KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED) , KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED) , KG/HR (LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

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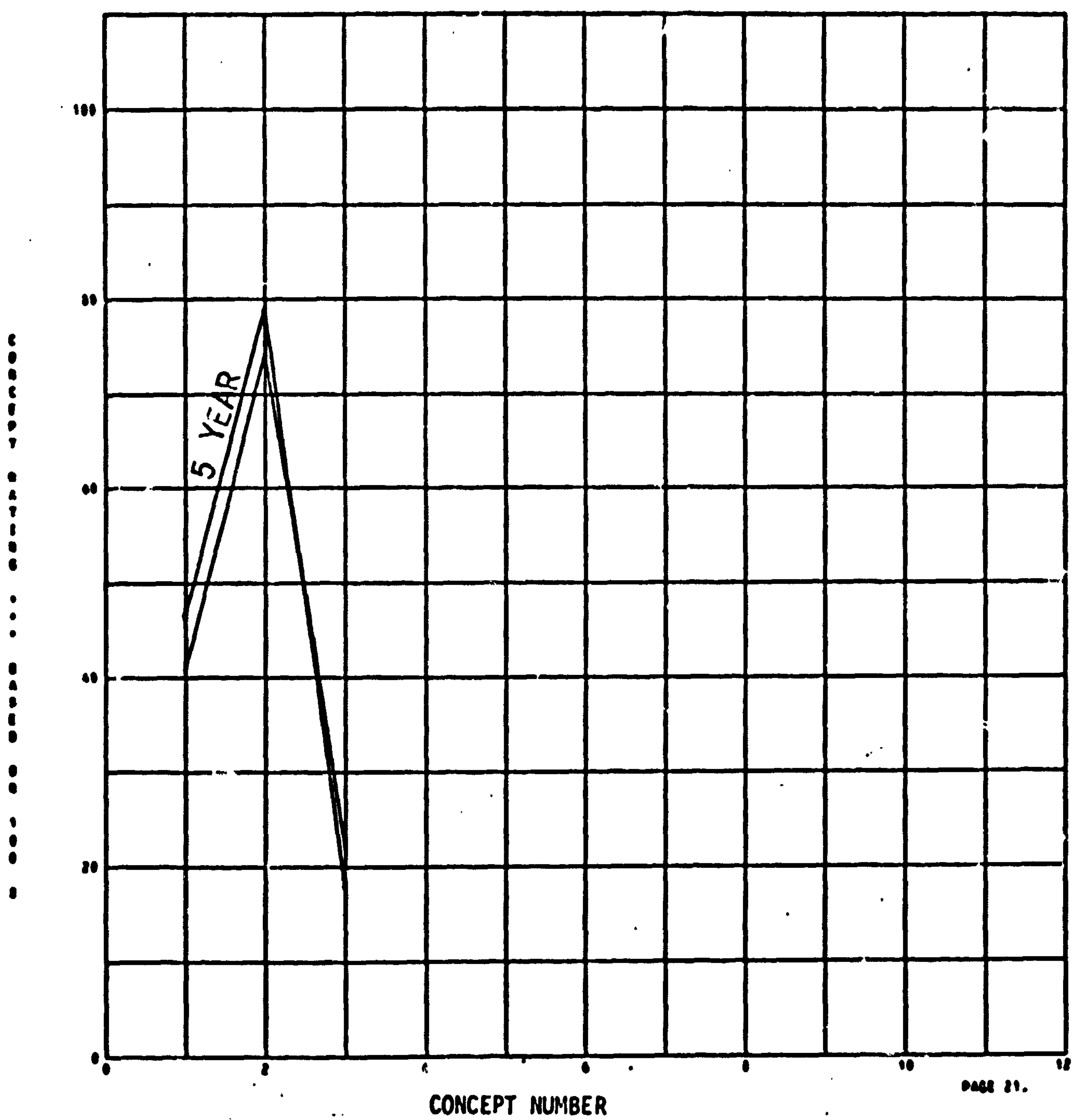
APPLIANCE CONCEPT NO. — CONCEPT NAME

1 - VACUUM STORAGE
2 - STORAGE BIN/CONTAINER
3 - SOLID PROPELLANT REFUSE ROCKET



Refuse Disposal (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 15
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX * * * * * REFUSE DISPOSAL (SPACE STATION)
(12/09/74)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	97.600	548.00	15	.77	12.33	.00
POWER	.00000	5.9100	15	15.00	15.00	.00
VOLUME	25.900	587.00	10	.00	.03	9.56
RELIAB-Y	.99997	1.0000	5	.00	5.00	4.81
MAINTENC	1.00000	1.0000	5	.00	5.00	.00
DEV COST	10.000	35.000	15	10.71	10.71	.00
TOTAL PT	.00000	65.000	65	26.48	48.08	14.37
RATING	.00000	100.00	100	40.74	73.96	22.11

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	40.74	73.96	22.11
WEIGHT	37.05	74.82	19.82
POWER	46.87	76.66	19.82
VOLUME	37.83	68.71	27.36
RELIAB-Y	39.23	74.93	24.86
MAINTENC	39.23	74.93	21.29
DEV COST	43.91	73.70	19.82

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	40.74	73.96	22.11
WEIGHT	45.39	72.89	24.99
POWER	33.01	70.57	24.99
VOLUME	44.13	80.10	15.99
RELIAB-Y	42.37	72.92	19.14
MAINTENC	42.37	72.92	22.99
DEV COST	36.74	74.30	24.99

073343

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 15
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • REFUSE DISPOSAL (SPACE STATION)
(12/09/74)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	97.600	548.CO	15	.77	12.33	.00
POWER	.00000	5.9100	15	15.00	15.00	.00
VOLUME	25.900	587.CO	10	.00	.03	9.56
RELIAB-Y	.99973	1.0000	5	.00	5.00	4.81
MAINTENC	1.00000	1.0000	5	.00	5.00	.00
DEV COST	10.000	35.000	15	10.71	10.71	.00
REC COST	1.8600	421.40	15	10.72	14.93	.00
TOTAL PT	.00000	80.000	80	37.20	63.01	14.37
RATING	.00000	100.00	100	46.50	78.76	17.97

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	CONCEPT 2	CONCEPT 3
NORMAL	46.50	78.76	17.97
WEIGHT	42.95	79.06	16.43
POWER	51.08	80.58	16.43
VOLUME	43.76	74.15	22.53
RELIAB-Y	45.09	79.41	20.34
MAINTENC	45.09	79.41	17.42
DEV COST	48.63	78.13	16.43
REC COST	48.64	80.55	16.43

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	CONCEPT 2	CONCEPT 3
NORMAL	46.50	78.76	17.97
WEIGHT	50.78	78.41	19.83
POWER	40.96	76.57	19.83
VOLUME	49.60	83.99	12.79
RELIAB-Y	48.00	78.08	15.44
MAINTENC	48.00	78.08	18.55
DEV COST	43.92	79.52	19.83
REC COST	43.92	76.61	19.83

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.2.5-REFUSE DISPOSAL

APPLIANCE TYPE / COMPONENT TYPE	NUMBER OF COMPONENTS: ACTUATOR	MANUAL VALVE	ROCKET MOTOR	MOTOR IGNITER													NUMBER OF SAFETY CRITICAL ITEMS
NO.	1	23	*	*													
VACUUM STORAGE/RESTORAGE/ BIOLOGICAL STABILIZED	1	1	-	-													0
STORAGE BIN/CONTAINER/RESTORAGE/ BIOLOGICAL STABILIZED	-	-	-	-													0
SOLID PROPELLANT REFUSE ROCKET	1	1	UNK	UNK													0

*TBD

SPACECRAFT Space Station

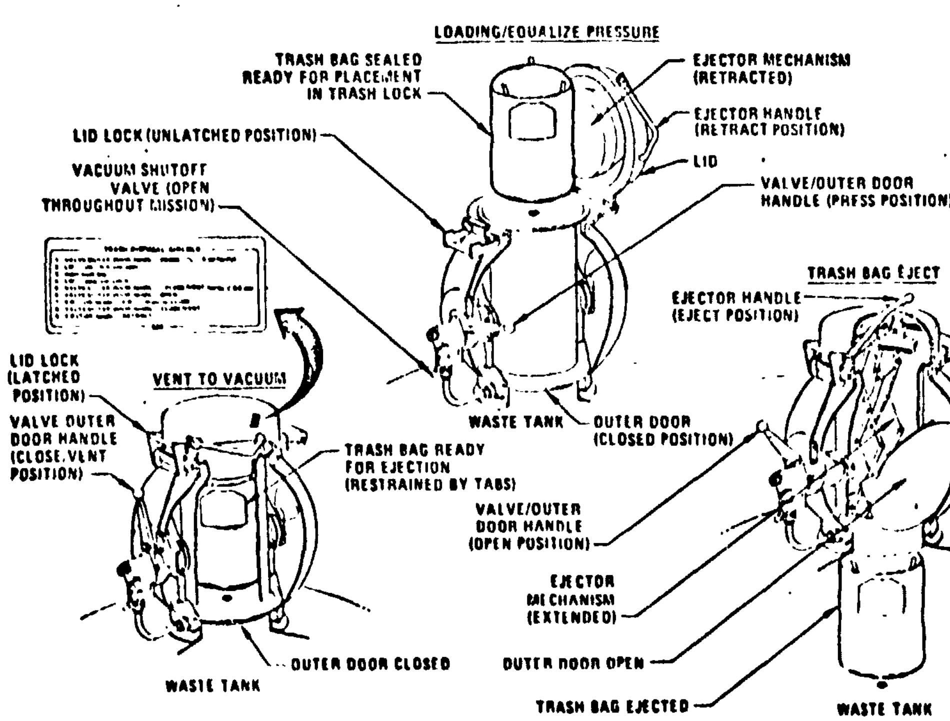
HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Disposal

APPLIANCE CONCEPT NO./TITLE 1/Vacuum Storage

INDEX NO. 3.2.5.1 REF. NO. MacDac, 283, 297

DESCRIPTION: The vacuum storage concept considered was the same as used for Skylab. The Skylab airlock was used as the means to deposit refuse into the vacuum storage tank. The vacuum environment stops bacterial growth in the refuse. The internal volume of the airlock is 4.3 ft^3 and was used to calculate the cabin air lost during each airlock refuse disposal cycle. The vacuum container was assumed to be a 10.4 foot diameter spherical tank fabricated of 6061 aluminum. The 10.4 foot diameter tank can be accommodated in both the Space Station and the Shuttle payload bay. Aluminum, 6061, was chosen as a material for the following reasons: (1) inexpensive, (2) easy to work, and (3) good weldability. The tank was assumed to be a pressure vessel with a maximum working pressure of 14.7 psi. The number of uses per mission was based on the size of Skylab disposal and trash bags. The trash bags are fabricated of a material which will retain water, but will also allow the bag to breath to allow pumpdown of the refuse to the vacuum pressure of the tank. Operation of the airlock was assumed to be 2 minutes per cycle.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 1/VACUUM STORAGE

INDEX NUMBER 3.2.5.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①X⑦
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT I/VACUUM STORAGE INDEX NUMBER 3.2.5.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
STORAGE TANK (6061 ALUM)	239	585
REFUSE AIRLOCK (233)	158	2
TOTAL	180.1 (397) KG (LBS)	16.6 (587) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ ____ TOTAL WT/CYCLE (LB) Σ⑤ ____ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
CABIN AIR	.321	N/A	N/A	.321

Σ① .321 Σ④ .321

TOTAL WT. MISSION = 2.08 CYCLE/DAY x 184 DAYS/MISSION x .321 TOTAL LOST/CYCLE (Σ④) = 122.8 (LB) + N/A (Σ①) = 55.79 (123) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

APPLIANCE FUNCTION Refuse Disposal

APPLIANCE CONCEPT NO./TITLE 2/Storage Bin/Container

INDEX NO. 3.2.5.2 REF. NO. 170

DESCRIPTION: The storage bin/container concept employs a locker to store the refuse. Sterilant capsules were assumed for retarding the bacterial growth. The refuse was assumed to be collected by bags (Skylab, or equivalent, and transferred to the storage locker. A concept provides a sterilant capsule for each bag of refuse stored in the locker. The capsules used for the study were 2.25 grams each with a volume of .33 cubic inches. The walls of the storage locker were assumed to be aluminum. Sizing of the locker was based on the refuse volume including the storage bags.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/STORAGE BIN/CONTAINER INDEX NUMBER 3.2.5.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)X(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)X(7)
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/STORAGE BIN/CONTAINER INDEX NUMBER 3.2.5.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
STORAGE BIN (6061 ALUM)	95.7	585
STERILANT CAPSULES	1.9	.073
TOTAL	44.27 (97.6) KG (LBS)	16.56 (585.1) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
STERILANT CAPSULES	1	.00496	.00496	.000191	.000191

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ .000191 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2.08 CYCLES/DAY x 184 DAYS/MISSION x .00496 TOT.WT/CYCLE (LB) = .862 (1.9) KG (LB)

TOTAL VOL MISSION = 2.08 CYCLES/DAY x 184 DAYS/MISSION x .000191 TOT.VOL/CYCLE (FT^3) = .002 (.073) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE @ ④ = ______ (LB) + ______ @ ① = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Refuse Management

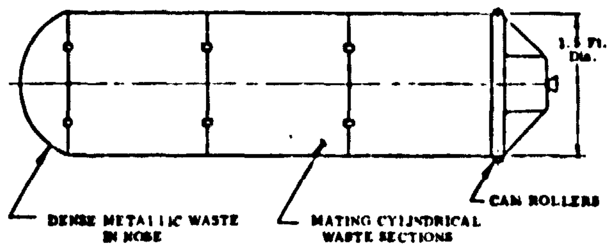
APPLIANCE FUNCTION Refuse Processing

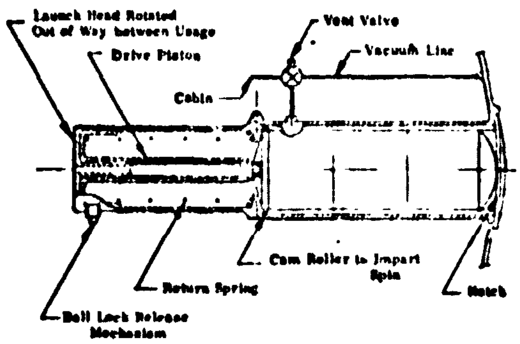
APPLIANCE CONCEPT NO./TITLE 3/Solid Propellant Refuse Rocket

INDEX NO. 3.2.5.3 REF. NO. 202

DESCRIPTION: The solid propellant refuse rocket concept utilizes a rocket to jettison refuse to earth for aerodynamic incineration. The study assumes the refuse is jettisoned from a 300 nautical mile orbit using an incremental velocity (ΔV) of 434 feet/second to alter the rockets velocity to cause it to reenter the earth atmosphere. Atmosphere drag at the 300,000 foot re-entry altitude chosen for the calculations (reference 202) is of such magnitude as to cause the trajectory to degenerate rapidly. The equation for a minimum energy Hohmann transfer ellipse were used for determining the required velocity increment for reentry. A solid rocket was chosen because a solid rocket is easy to use and transport, and may be fired with simple electrical circuits. The ability of solid propellants to withstand long storage periods at extremes in temperature and pressure without attention is also a benefit for this type of application. The solid rocket in this application is superior to a liquid rocket in total impulse to total weight ratio primarily because of the greater energy per unit volume. Therefore, less dead weight structure is required to carry the propellant. The size of the rocket was based on the total refuse volume compressed by a compactor to minimize the rocket volume. The concept was penalized for a compactor with a compression ratio of 0.2. (Air Pressure Type).

Waste Rocket





Operation:

Rotate launch handle to "eject" position (not shown). The following events occur automatically:

1. Launch tube is vented to space and then hatch opens.
2. Launch piston is released and rocket is spin ejected. Cabin pressure provides launch force. Helical groove in launch tube imparts spin.
3. Hatch closes.
4. Launch tube is vented to cabin and spring retracts launch piston.

Launch Tube for Spin Ejecting Waste Rocket

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/SOLID PROPELLANT REFUSE ROCKET INDEX NUMBER 3.2.5.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(7)
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
COMPACTOR (AIR PRESSURE)	—	—	10	75	2.0
WASTE COLLECTION BAGS	—	—	--	48.2	4.61
TOTAL	— WATTS/CYCLE (BTU/HR/CYCLE)	— WATTS/CYCLE (BTU/HR/CYCLE)	10	55.9 KG/MISSION (123.2) (LB/MISSION)	.21 M^3/MISSION (7.41) (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONTINUED)

CONCEPT 3/ SOLID PROPELLANT REFUSE ROCKET   INDEX NUMBER 3.2.5.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
ROCKET MOTOR	(202)	349	3.51
EJECTION MECHANISM		50	15.00
TOTAL		181 (399) KG (LBS)	.524 (18.51) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
ROCKET MOTORS	1 (202)	19.40 (202)	19.40	.195 (202)	.195

Σ③ 19.40 TOTAL WT/CYCLE (LB)   Σ⑤ .195 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = .0978 CYCLES/DAY x 184 DAYS/MISSION x 19.40 TOT.WT/CYCLE (LB) = 158.4 (349) KG (LB)

TOTAL VOL MISSION = .0978 CYCLES/DAY x 184 DAYS/MISSION x .195 TOT.VOL/CYCLE (FT^3) = .0993 (3.51) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ①   Σ④

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE ≈ ④ = ____ (LB) ≈ ① = ____ KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.3 Garment/Linen Maintenance

APPLIANCE FUNCTION 3.3.1 Garment/Linen Washing

NUMBER OF CONCEPTS CONSIDERED 10

ASSUMPTIONS

A number of references were found which present data for various clothes washer and dryer concepts (Reference 70, 90, 91, 100, 127, 161, 1?1, 185, 202, 237 and 245). These references were reviewed in detail, and the engineering data from each examined. It was soon found that much of the data did not agree. The primary reason for discrepancies was that the data were mostly very sketchy, without detailed breakdowns to define the data. For example, the clothes washer weight in one reference would include the agitator tub only, while another would include peripheral equipment such as water accumulators, processing equipment or other miscellaneous items. One reference was found (#90) which contained all the concepts found throughout the other reports and presented the data for each in a consistent manner for direct comparison. Therefore, it was decided to collect all the clothes washer and dryer data for this study from Reference 90.

A ground rule of 2-clothes washings per day was assumed from Reference 273. For this condition, and assuming a 6-man space station crew, a detailed study of Space Station clothing usage (Reference 245) has shown a maximum laundry load of 1.66 kg (3.68 lbs). Since the clothes washer load assumed in Reference 90 is only slightly larger than this, or 1.81 kg (4.0 lbs), the data from that reference were used directly without adjusting

The water usage for the automatic concept was assumed 24.9 kg (55 lbs) for washing and 24.9 kg (55 lbs) for rinse as recommended in Reference 273. Rinse water was assumed to be temporarily stored to be reused as wash water. Wash/rinse time was taken to be one hour.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.3.1 **** GARMENT/LINEN WASHING (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1458. (4980.)	225.0 .0	.0 .0	159.9 (352.5)	.51 (18.10)	0	70	18.9 (41.6)
2	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 .0	.0 0	156.7 (345.5)	.54 (19.10)	0	60	18.9 (41.6)
3	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	593. (2025.)	1385. (4728.)	216.0 681.0	.0 .0	241.0 (575.5)	2.04 (71.90)	0	90	18.9 (41.6)
4	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	593. (2025.)	1352. (4618.)	216.0 681.0	.0 .0	265.1 (584.5)	2.04 (71.90)	0	90	18.9 (41.6)
5	2.000 1.030	7 9	.1361 (.3000) 49.8960 (110.0000)	.00 (.00) .00 (.00)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	1308. (4468.)	75.0 .0	.0 .0	188.9 (416.5)	.44 (15.70)	0	95	67.7 (149.2)
6	2.000 1.000	7 9	.1769 (.3900) 49.8960 (110.0000)	.00 (.00) .00 (.00)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	1308. (4468.)	75.0 .0	.0 .0	197.1 (434.5)	.43 (15.20)	0	95	82.3 (181.5)
7	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 .0	.0 .0	159.9 (352.5)	.53 (18.10)	0	90	18.9 (41.6)
8	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	2770. (9460.)	1537.0 .0	.0 .0	166.7 (367.5)	.57 (20.10)	0	60	18.9 (41.6)
9	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	395. (1350.)	254. (868.)	194.0 454.0	.0 .0	117.8 (259.6)	1.22 (43.10)	0	50	16.8 (37.0)
10	2.000 1.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 .0	.0 .0	159.9 (352.5)	.53 (18.60)	0	50	18.9 (41.6)

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APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	MECHANICAL OSCILLATION
2 -	FLUIDIC AGITATION
3 -	PISTON AGITATION
4 -	CYCLIC VALVE AND PUMP AGITATION
5 -	DIAPHRAM ACTUATED-ONE DIRECTIONAL SQUEEZE
6 -	DIAPHRAM ACTUATED-TWO DIRECTIONAL SQUEEZE
7 -	WATER SPRAY AGITATED
8 -	ULTRASONIC
9 -	MANUAL WASHBOARD
10 -	PLAIN RECIRCULATION

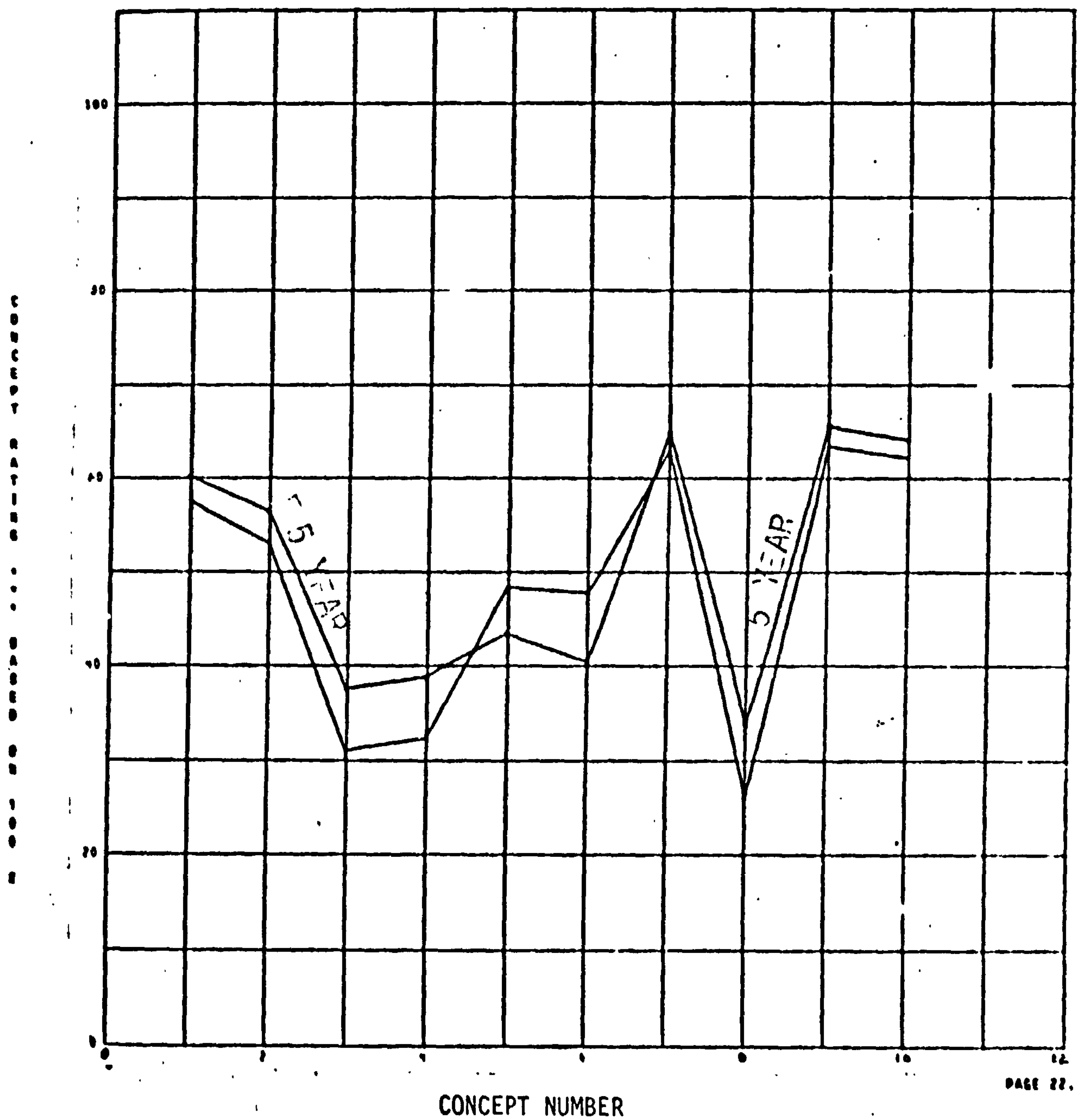
(*)

1 - CABIN AIR	(CIRCULATED),	LITERS/SEC	(FT^3/MIN)
2 - CABIN AIR	(LOST) ,	KG/HR	(LB/HR)
3 - OXYGEN	(LOST) ,	KG/HR	(LB/HR)
4 - COOLING WATER	(CIRCULATED),	KG/HR	(LB/HR)
5 - WATER	(LOST) ,	KG/HR	(LB/HR)
6 - NITROGEN	(CIRCULATED),	KG/HR	(LB/HR)
7 - NITROGEN	(USED) ,	KG/HR	(LB/HR)
8 - FREON	(CIRCULATED),	KG/HR	(LB/HR)
9 - WATER	(PROCESSED) ,	KG/HR	(LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

13333

APPLIANCE CONCEPT NO.		CONCEPT NAME
1	-	MECHANICAL OSCILLATION
2	-	FLUIDIC AGITATION
3	-	PISTON AGITATION
4	-	CYCLIC VALVE AND PUMP AGITATION
5	-	DIAPHRAM ACTUATED-ONE DIRECTIONAL SQUEEZE
6	-	DIAPHRAM ACTUATED-TWO DIRECTIONAL SQUEEZE
7	-	WATER SPRAY AGITATED
8	-	ULTRASONIC
9	-	MANUAL WASHBOARD
10	-	PLAIN RECIRCULATION



Garment/Linen Washing (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 1
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX • • • • • GARMENT/LINEN WASHING (SPACE STATION)
(04/18/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9	10
WEIGHT	259.60	584.50	15	5.95	6.13	.23	.00	4.31	3.85	5.95	5.57	8.34	5.95
POWER	53.250	1091.3	15	12.80	12.69	7.36	7.36	14.27	14.27	12.69	.00	9.91	12.69
VOLUME	15.200	71.900	10	7.48	7.34	.00	.00	7.82	7.89	7.41	7.20	4.01	7.41
THERMAL	184.00	1210.9	15	7.10	7.04	6.15	6.32	7.92	7.92	7.04	.00	12.72	7.04
RELIAB'Y	.95585	.99073	5	3.35	1.39	3.41	3.95	3.33	3.33	3.41	.00	3.41	3.79
MAINTENC	.99995	.99999	5	3.30	.00	3.39	4.11	3.43	3.43	3.39	.78	3.40	3.84
SAFETY	.00000	3.0000	5	5.00	5.00	5.00	5.00	.00	.00	5.00	3.33	5.00	5.00
DEV COST	40.000	95.000	15	3.95	5.53	.79	.79	.00	.00	8.68	5.53	7.11	7.11
TOTAL PT	.00000	85.000	85	48.94	45.12	26.33	27.53	41.07	40.68	53.58	22.42	53.89	52.83
RATING	.00000	100.00	100	57.58	53.08	30.97	32.39	48.32	47.86	63.03	26.37	63.40	62.15

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10
NORMAL	57.58	53.08	30.97	32.39	48.32	47.86	63.03	26.37	63.40	62.15
WEIGHT	56.13	52.09	28.59	29.77	46.73	46.06	61.14	27.24	62.76	60.33
POWER	59.83	55.63	32.44	33.74	52.12	51.69	64.78	24.23	63.61	63.97
VOLUME	58.53	54.21	29.25	30.59	49.98	49.58	63.65	28.91	62.10	62.81
THERMAL	56.75	52.58	31.79	33.18	48.68	48.26	61.73	24.23	65.13	60.91
RELIAB-Y	57.84	52.35	32.04	33.72	48.84	48.39	63.18	25.62	63.53	62.54
MAINTENC	57.82	51.56	32.03	33.82	48.90	48.45	63.17	26.07	63.53	62.57
SAFETY	58.79	54.42	32.95	34.32	46.94	46.49	64.09	27.52	64.44	63.23
DEV COST	55.04	51.76	28.89	30.19	44.40	43.98	62.62	27.22	62.10	60.95

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10
NORMAL	57.58	53.08	30.97	32.39	48.32	47.86	63.03	26.37	63.40	62.15
WEIGHT	59.31	54.26	33.82	35.53	50.22	50.01	65.29	25.33	64.15	64.32
POWER	54.89	50.03	29.22	30.78	43.79	43.29	60.95	28.92	63.14	59.98
VOLUME	56.50	51.81	32.91	34.42	46.46	45.92	62.34	23.52	64.85	61.40
THERMAL	58.56	53.67	30.01	31.45	47.69	47.38	64.59	28.92	61.32	63.62
RELIAB-Y	57.29	53.85	29.85	30.98	47.77	47.29	62.88	27.17	63.25	61.73
MAINTENC	57.32	54.69	29.86	30.88	47.70	47.23	62.89	26.70	63.26	61.71
SAFETY	56.29	51.66	28.88	30.34	49.79	49.31	61.91	25.15	62.29	61.00
DEV COST	60.60	54.65	33.46	35.02	53.00	52.49	63.53	25.36	64.95	63.58

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 1
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - - GARMENT/LINEN WASHING (SPACE STATION)
(04/18/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9	10
WEIGHT	259.60	584.50	15	5.95	6.13	.23	.00	4.31	3.65	5.95	5.57	8.34	5.95
POWER	53.250	1091.3	15	12.80	12.69	7.36	7.36	14.27	14.27	12.69	.00	9.91	12.69
VOLUME	15.200	71.900	10	7.48	7.34	.00	.00	7.82	7.89	7.41	7.20	4.01	7.41
THERMAL	184.00	1210.9	15	7.10	7.04	6.15	6.32	7.92	7.92	7.04	.00	12.72	7.04
RELIAB-Y	.63253	.90982	5	3.11	1.18	3.18	3.77	3.10	3.10	3.18	.00	3.18	3.60
MAINTENC	.99995	.99999	5	3.30	.00	3.39	4.11	3.43	3.43	3.39	.78	3.40	3.84
SAFETY	.00000	3.0000	5	5.00	5.00	5.00	5.00	.00	.00	5.00	3.33	5.00	5.00
DEV COST	40.000	95.000	15	3.95	5.53	.79	.79	.00	.00	8.68	5.53	7.11	7.11
REC COST	37.000	181.47	15	11.56	11.56	11.56	11.56	2.67	.00	11.56	11.56	11.94	11.56
TOTAL PT	.00000	100.00	100	60.27	56.48	37.66	38.92	43.51	40.45	64.91	33.98	65.60	64.19
RATING	.00000	100.00	100	60.27	56.48	37.66	38.92	43.51	40.45	64.91	33.98	65.60	64.19

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10
NORMAL	60.27	56.48	37.66	38.92	43.51	40.45	64.91	33.98	65.60	64.19
WEIGHT	58.83	55.39	35.14	36.20	42.48	39.42	63.15	34.20	64.90	62.49
POWER	62.02	58.44	38.46	39.63	47.11	44.26	66.28	31.61	65.63	65.62
VOLUME	60.96	57.29	35.87	37.07	45.16	42.28	65.35	35.79	64.38	64.67
THERMAL	59.37	55.81	37.90	39.14	44.15	41.31	63.66	31.61	66.94	62.99
RELIAB-Y	60.32	55.60	38.29	39.81	43.96	40.97	64.88	33.15	65.55	64.38
MAINTENC	60.41	55.10	38.40	39.98	44.12	41.14	64.98	33.53	65.66	64.50
SAFETY	61.24	57.54	37.18	40.41	42.45	39.46	65.77	34.78	66.44	65.07
DEV COST	57.90	55.11	35.40	36.57	40.47	37.63	64.42	34.18	64.33	63.02
REC COST	61.44	57.92	40.41	41.58	41.71	37.63	65.76	36.99	66.58	65.09

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9	10
NORMAL	60.27	56.48	37.66	38.92	43.51	40.45	64.91	33.98	65.60	64.19
WEIGHT	61.94	57.74	40.59	42.07	44.71	41.65	66.96	33.72	66.41	66.18
POWER	58.24	54.20	36.74	38.10	39.32	36.01	63.32	36.73	65.56	62.54
VOLUME	59.50	55.59	39.65	40.97	41.68	38.43	64.43	31.98	66.94	63.67
THERMAL	61.32	57.25	37.39	38.66	42.76	39.45	66.37	36.73	64.04	65.59
RELIAB-Y	60.22	57.32	37.00	37.98	43.04	39.90	64.95	34.85	65.65	64.00
MAINTENC	60.12	57.93	36.89	37.81	42.84	39.72	64.84	34.45	65.54	63.87
SAFETY	59.25	55.36	36.06	37.35	44.62	41.48	64.01	33.14	64.72	63.28
DEV COST	63.02	58.07	40.29	41.65	47.04	43.73	65.48	33.75	67.08	65.56
REC COST	58.91	54.81	34.47	35.82	45.59	43.73	63.93	30.48	64.46	63.15

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.3.1-GARMENT/LINEN/WASHING

APPLIANCE TYPE \ COMPONENT TYPE NO.	MOTOR (1)	PUMP (2)	SOLENOID VALVE (3)	ACCUMULATOR (4)	ACCUMULATOR BLADDER (5)	WATER SEPARATOR (6)	TRANSMISSION (7)	FLUIDIC SWITCH (8)	FILTER (9)	ELECTRIC SWITCH (10)	PRESSURE REGULATOR (11)	VALVE (PNEUMATIC) (12)	CONTROLLER (13)	HIGH FREQUENCY CONTROLLER (14)	ELECTROACOUSTIC TRANSDUCER (15)	( )	NUMBER OF SAFETY CRITICAL ITEMS
NONDISPOSABLE CLOTHES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		0
MECHANICAL OSCILLATION (pg. 21)	2	1	2	2	-	1	1	-	1	4	-	-	-	-	-		1
FLUIDIC AGITATION (pg. 24)	5	2	2	2	-	1	-	10	1	7	-	-	-	-	-		0
PISTON AGITATION (pg. 27)	2	1	2	2	-	1	-	-	1	4	-	-	-	-	-		0
CYCLIC VALVE AND PUMP (pg. 29)	-	1	2	2	-	1	-	-	-	3	-	-	-	-	-		0
DIAPHRAGM ACTIVATED-ONE DIRECTIONAL SQUEEZE (pg. 31)	-	1	2	-	2	1	-	-	-	4	1	1	1	-	-		3
DIAPHRAGM ACTIVATED-TWO DIRECTIONAL SQUEEZE (pg. 24)	-	1	2	-	2	1	-	-	-	4	1	1	1	-	-		3
WATER SPRAY AGITATED (pg. 36)	2	1	2	2	-	1	-	-	1	4	-	-	-	-	-		0
ULTRASONIC WASHER (pg. 38)	2	1	2	2	-	1	-	-	-	4	-	-	-	1	1		1
MANUAL WASHBOARD (pg. 41)	2	1	2	2	-	1	-	-	-	4	-	-	-	-	-		0
PLAIN RECIRCULATION (pg. 45)	1	1	2	2	-	1	-	-	1	3	-	-	-	-	-		0

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

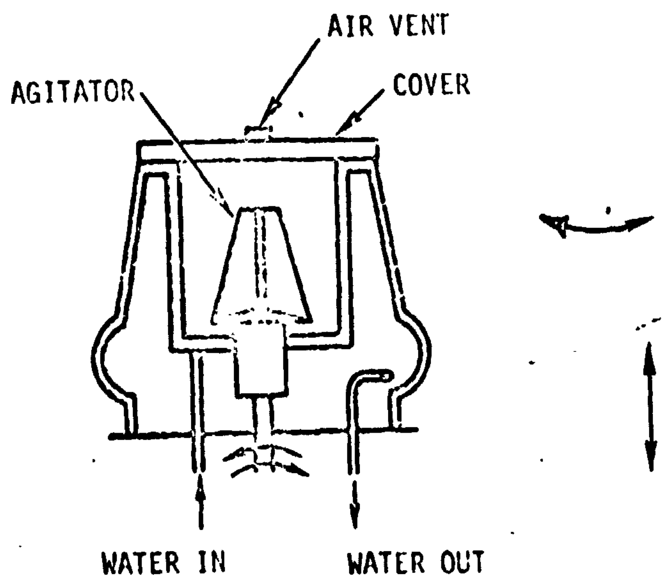
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 1/Mechanical Oscillation

INDEX NO. 3.3.1.1 REF. NO. 90

DESCRIPTION

This concept is similar to a conventional washer. A central agitator provides the washing either by rotational or translational oscillation. A high-speed rotation extracts wash and rinse water and is used to spin dry the clothes before final drying.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *Mechanical oscillation* INDEX NUMBER *3.2.1.1*

(Ref. #92 p. [illegible])

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valving	*0*	*55*	*0*	*0*			
Pump	*1*	*20*	*20*				
Agitator motor	*1*	*150*	*150*				
		205 MAXIMUM		TOTAL	*0* MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss (40°F)	*0*	*4400*	*4400*	*0*
Pump	*0*	*68*	*68*	*0*
Agitator motor	*0*	*512*	*512*	*0*
TOTAL	*0* WATT (BTU/HR)	*1459 (4980)* WATT (BTU/HR)	*1459 (4980)* WATT (BTU/HR)	*0* WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER 2.3.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
Basic washer	80	10
Accumulator [illegible]	40	3.[illegible]
[illegible] pump	4	
Valves	6	
Water [illegible]	3	
Packaging	67	
Miscellaneous	——	[illegible]
TOTAL	90.7 ([illegible]) KG (LBS)	0.493 (17.4) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
Detergent/ Germicide	1	.055 ([illegible])	.066	.0019 ([illegible])	.0019
		Σ③	.066 TOTAL WT/CYCLE (LB)	Σ⑤	.0019 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 2 CYCLES/DAY x 180 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 180 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT³) = 0.02[illegible] (0.[illegible]) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	55	.9991		.0495
Rinse water	55	1.000		0
	Σ① 110		Σ④	.0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 180 DAYS/MISSION x .0495 TOTAL [illegible] /CYCLE ([illegible]) = [illegible] (LB) + 110 (x ①) = 58.2 ([illegible]) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

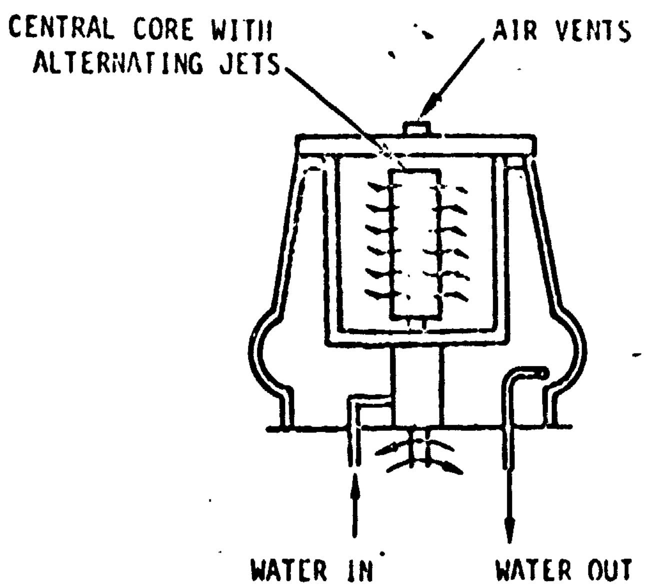
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 2/Fluidic Agitation

INDEX NO. 3.3.1.2 REF. NO. 90

DESCRIPTION

In this concept, water is sprayed through a central column of stacked fluidic switches which direct water in alternating directions through jets. A high-speed rotation extracts wash and rinse water, and is used to spin-dry the clothes before final drying.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible] (1.1.5.90, [illegible]) INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valve	0	55	0				
Pump	1	[illegible]	[illegible]				
Agitator motor	1	150	150				
		277 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss ([illegible])	0	4400	4400	0
Pump	0	109	109	0
Agitator motor	0	512	512	0
TOTAL	0 WATT (BTU/HR)	1471 ([illegible]) WATT (BTU/HR)	14[illegible] ([illegible]) WATT (BTU/HR)	0 WATT (BTU/HR)

ORIGINAL PAGE IS OF POOR QUALITY

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Fluidic agitation (Ref. #90 p74,75) INDEX NUMBER 3.3.1.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Basic washer	79	10
Pump	4	
2 accumulators	40	3.6
Valves	6	
Water separator	3	
Packing	[illegible]	
Miscellaneous	—	4.8
TOTAL	87.5 (173) KG (LBS)	0.52 (18.4) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent/ Germicide	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	55	.9991		.0495
Rinse water	55	1.000		0

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) + 110 (Σ①) = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

APPLIANCE FUNCTION Garment/Linen Washing

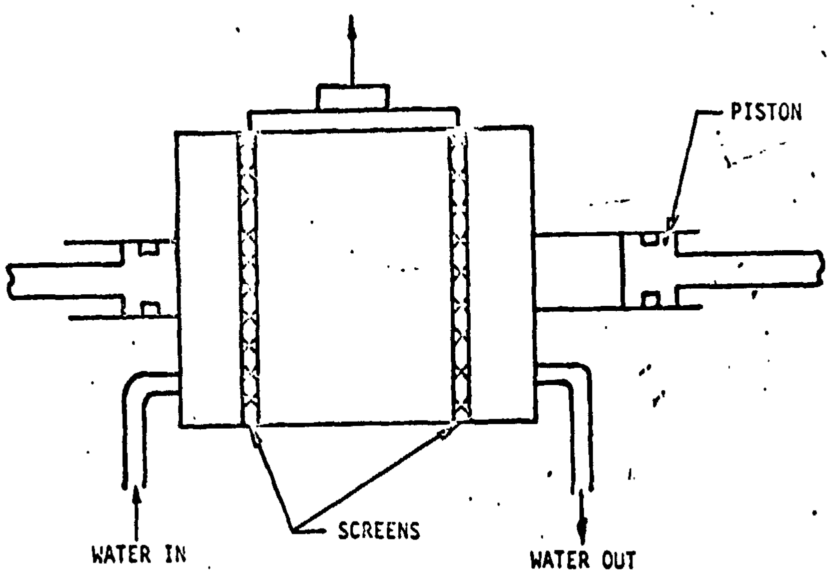
APPLIANCE CONCEPT NO./TITLE 3/Piston Agitation

INDEX NO. 3.3.1.3 REF. NO. 90

DESCRIPTION

In this concept, two pistons are actuated alternately to pump water back and forth within the drum. Screens are added to increase turbulence and to contain the clothing within the drum.

Since there is no spin-dry capability, it was assumed, as recommended in Reference 90, that 1.36 kg (3.0 lbs) of water are left in the clothes over and above the water left by the other concepts after spin-dry. Therefore, a dryer penalty was assumed to handle this added water. For this purpose, the dryer concept 3.3.2.1 was assumed (forced hot air electric) since it had already been selected in the past (Reference 237) to build a prototype clothes dryer. Since the dryer penalties were based on removing 0.456 kg (1.0 lb) of water, and this washer concept has 1.36 kg (3.0 lb) extra water to be dried, all the penalties for dryer concept 3.3.2.1 were multiplied by 3 and added to the penalties for this clothes washer concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Piston agitation (Ref #90 p. [illegible]) INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valving		0	55					
Motor		1	64					
Pump		1	32					
			151 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss ([illegible])	0	4400	4400	0
Pump	0	109	109	0
Motor	0	219	219	0
TOTAL	0 WATT (BTU/HR)	1385 (4728) WATT (BTU/HR)	1385 (4728) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
3 times dryer concept #[illegible], assumed to dry 3 lbs of water extra above the alternate concepts	1089	2025	216 AC 681 DC	240	52.8
TOTAL	319 (1089) WATTS/CYCLE (BTU/HR/CYCLE)	593 (2025) WATTS/CYCLE (BTU/HR/CYCLE)	216 AC 681 DC	109 (240) KG/MISSION (LB/MISSION)	1.50 (52.8) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER [illegible]

(Ref #90 p 27,28)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
F[illegible] washer		70	10
2 [illegible]		4[illegible]	2.6
Valve[illegible]		6	
Water [illegible]		[illegible]	
Pump		4	
Packaging		60	
Miscellaneous		—	4.[illegible]
TOTAL		83.0 ([illegible]) KG (LBS)	0.52 (1[illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent / Germicide	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	55	.9991		.0495
Rinse water	55	1.00		0

Σ① ______ Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) + 110 (Σ①) = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

APPLIANCE FUNCTION Garment/Linen Washing

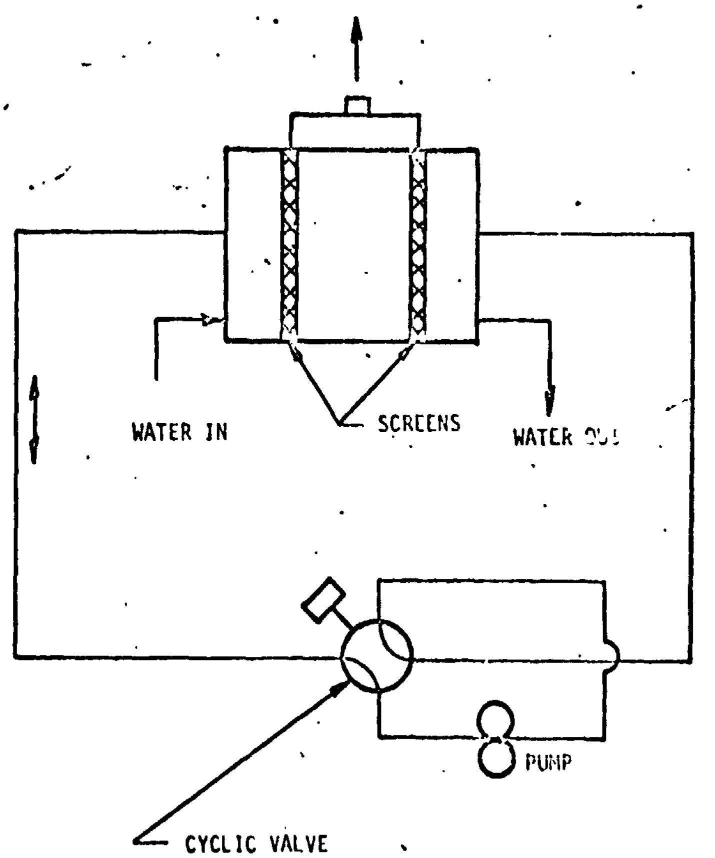
APPLIANCE CONCEPT NO./TITLE 4/Cyclic Valve and Pump

INDEX NO. 3.3.1.4 REF. NO. 90

DESCRIPTION

This concept is identical in operation to #4 (Piston Agitation), except that the water pumping is accomplished by a pump and cyclic valve rather than opposing pistons. Screens are included to contain the clothing within the drum as well as to increase turbulence.

No spin-dry capability was assumed, just as in concept #4, and again 1.36 kg (3.0 lb) additional water was assumed to require drying. This was handled in the same manner as was explained in concept #4; thus, all the penalties for dryer concept #3.3.2.1 were multiplied by 3 and added to the penalties for this clothes washer concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Cyclic valve & pump (Ref. # 90 & 29, 30)

INDEX NUMBER 3.3.1.4

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
Valve	0	55					
Pump	1	64					
		119 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat [illegible] (1400°F)	0	4400	4400	0
Pump	0	218	218	0
TOTAL	0 WATT (BTU/HR)	1353 (4618) WATT (BTU/HR)	1353 (4618) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
2 times dryer concept # 3.3.2.1, [illegible] to dry 2 lbs of water extra [illegible] allowance [illegible]	1089	2025	216 AC 681 DC	240	52.9
TOTAL	319 (1089) WATTS/CYCLE (BTU/HR/CYCLE)	593 (2025) WATTS/CYCLE (BTU/HR/CYCLE)	216 AC 681 DC	109 (240) KG/MISSION (LB/MISSION)	1.50 (52.9) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER 3.3.1.4

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
[illegible]	72	10
[illegible]	4[illegible]	3.[illegible]
[illegible]	1	
[illegible]	[illegible]	
[illegible]	2	
[illegible]	1[illegible]	
[illegible]		4.9
TOTAL	87.1 (192) KG (LBS)	0.52 ([illegible]) M³ (FT³)

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SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT) (REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
Detergent/ Germicide	1	.055 (.0[illegible])	.066	.0016 (.0017)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .00[illegible] TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT³) = 0.020 (.7[illegible]) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	55	.9991		.0495
Rinse water	55	1.000		0

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) + 110 (Σ①) = 58.2 ([illegible]) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

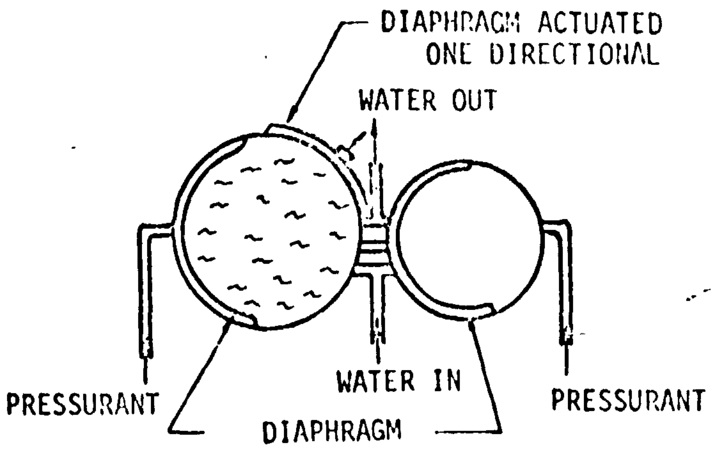
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 5/Diaphragm Actuated - One Directional Squeeze

INDEX NO. 3.3.1.5 REF. NO. 90

DESCRIPTION

This concept utilizes compressible diaphragms, operated by pressurized nitrogen, to alternately squeeze and soak the clothes. Wash and rinse water are removed at the end of each cycle by simultaneously pressurizing both diaphragms. This concept has been shown to be feasible, but its cleaning effectiveness remains to be proven by further testing.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible] INDEX NUMBER [illegible]

(Ref #90, p 31-[illegible])

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valve		0	55					
Pump		1	20					
			75 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss ([illegible])	0	44[illegible]	4400	0
Pump	0	65	65	0
TOTAL	0 WATT (BTU/HR)	1309 ([illegible]) WATT (BTU/HR)	1309 (4465) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER [illegible]

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FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]
TOTAL	47.2 ([illegible]) KG (LBS)	0.42 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent/ Germicide	1	.055 (.0[illegible])	.066	.001[illegible] (.00[illegible])	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 180 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 180 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.0[illegible] ([illegible]) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wa[illegible]	55	.99[illegible]		.0[illegible]
Rin[illegible]	50	1.0[illegible]		0
[illegible]	6.3	0		6.3

Σ① 111.3 Σ④ .3[illegible]

TOTAL WT. MISSION = [illegible] CYCLE/DAY x 180 DAYS/MISSION x .3[illegible] TOTAL LOST/CYCLE (Σ④) = 129 (LB) + 110.[illegible] (Σ①) = 109 (240) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

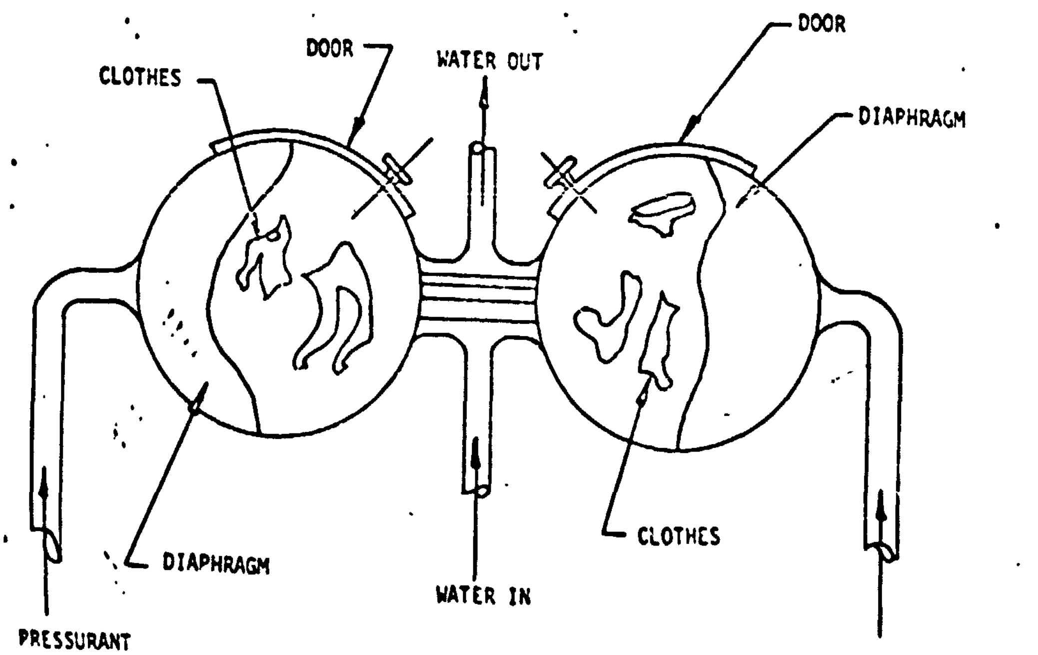
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 6/Diaphragm Actuated - Two Directional Squeeze

INDEX NO. 3.3.1.6 REF. NO. 90

DESCRIPTION

This concept is similar to concept #5 except that the clothes are stored in two tanks. Pressurized diaphragms are again used to alternately squeeze and soak the clothes. As in concept #5, cleaning effectiveness remains to be proven by further testing.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible] (Ref. #9: p. 34, 3[illegible]) INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT HR/CYCLE) ①x⑦
Valves	0	55					
Pump	1	20					
		75 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat [illegible] ([illegible])	0	4400	4400	0
Pump	0	6[illegible]	6[illegible]	0
TOTAL	0 WATT (BTU/HR)	1309 ([illegible]) WATT (BTU/HR)	1309 ([illegible]) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	[illegible]	7.0
[illegible]	4	
[illegible]	[illegible]	[illegible]
[illegible]	6	
[illegible]	2	
[illegible]	4	
[illegible]	2	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	—	3.9
TOTAL	63.1 ([illegible]) KG (LBS)	0.40 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent/ Germicide	1	.055 ([illegible])	.066	.0016 ([illegible])	.0019

Σ③ .066 TOTAL WT/CYCLE (LB)

Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
[illegible]	55	.9991		.0495
[illegible]	55	[illegible]		0
[illegible]	0.39	0		0.39

Σ① 110.79

Σ④ .4395

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .4395 TOTAL LOST/CYCLE ≈ ③ .. 162 (LB) + 110.79 ≈ ① = 124 (273) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

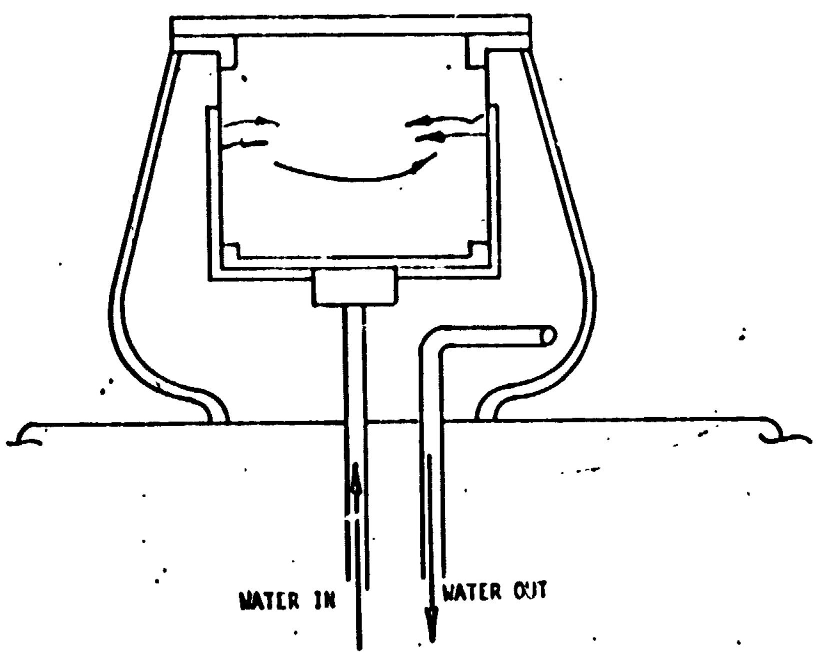
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 7/Water Spray Agitation

INDEX NO. 3.3.1.7 REF. NO. 90

DESCRIPTION

In this concept, a high velocity jet of water is sprayed into a wire mesh drum from the outer circumference. The drum is slowly rotated to allow continuous removal of the water. A high speed spin cycle is used to remove the excess water after washing and rinsing.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Water spray agitation (Ref. #90 p 36, 37)

INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①X⑦
Valves	0	55					
Pump	1	[illegible]					
Agitation motor	1	110					
		227 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss ([illegible])	0	4400	4400	0
Pump	0	108	108	0
Motor	0	512	512	0
TOTAL	0 WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER 2.3.1.7

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	80	10.5
Pum[illegible]	7	
[illegible]	[illegible]	2.(
Valv[illegible]	2	
Wat[illegible]	[illegible]	
Pack[illegible]	[illegible]	
Misc[illegible]	—	2.[illegible]
TOTAL	90.7 ([illegible]) KG (LBS)	0.507 ([illegible]) M^3 (FT^3)

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SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
[illegible] / Germicide	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash [illegible]	55	.9991		.0495
Rinse [illegible]	55	1.000		0

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) + 110 (Σ①) = 58.2 ([illegible]) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

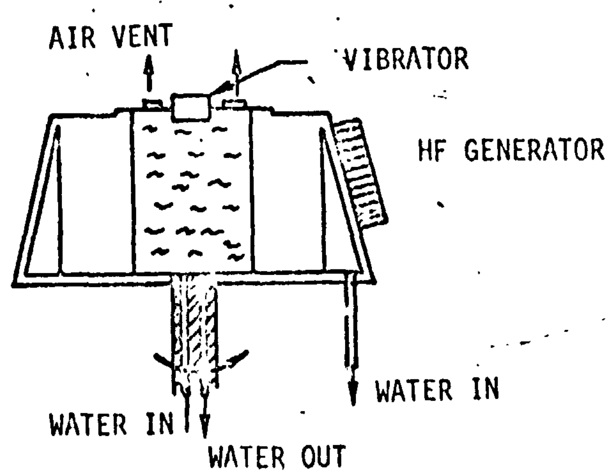
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 8/Ultrasonic

INDEX NO. 3.3.1.8 REF. NO. 90

DESCRIPTION

In this concept, ultrasonic energy is used to wash to clothes. A damping factor of 2 was assumed, which probably results in a gross underestimate of the actual electrical power required. The amount of water required was assumed to be the same as for the other washing concepts.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible]
(Ref #[illegible] p 2[illegible])

INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Pump	1	[illegible]					
[illegible] motor	1	150					
[illegible] generator	1	1200					
Valving	0	15					
		1537 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss (40°F)	0	4400	4400	0
Pump	0	109	109	0
Motor	0	512	512	0
[illegible] generator	0	[illegible]0	44[illegible]	0
TOTAL	0 WATT (BTU/HR)	2772 ([illegible]) WATT (BTU/HR)	2772 ([illegible]) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Ultrasonic INDEX NUMBER 3.2.1.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
Basic washer		[illegible]	12
[illegible]		1	
[illegible]		11	
[illegible]		[illegible]	[illegible]
Valving		[illegible]	
Water separator		[illegible]	
Packaging		[illegible]	
Miscellaneous		—	[illegible]
TOTAL		97.5 ([illegible]) KG (LBS)	0.55 ([illegible]) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
Detergent/ Germicide	1	.055 ([illegible])	.066	.0016 ([illegible])	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT³)

TOTAL WT. / MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL / MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT³) = 0.020 (0.7) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	.55	[illegible]		[illegible]
Rinse water	[illegible]	[illegible]		0

Σ① [illegible] Σ④ [illegible]

TOTAL WT. / MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x [illegible] TOTAL LOST/CYCLE (Σ ④) = [illegible] (LB) + 110 (Σ ①) = 58.2 ([illegible]) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

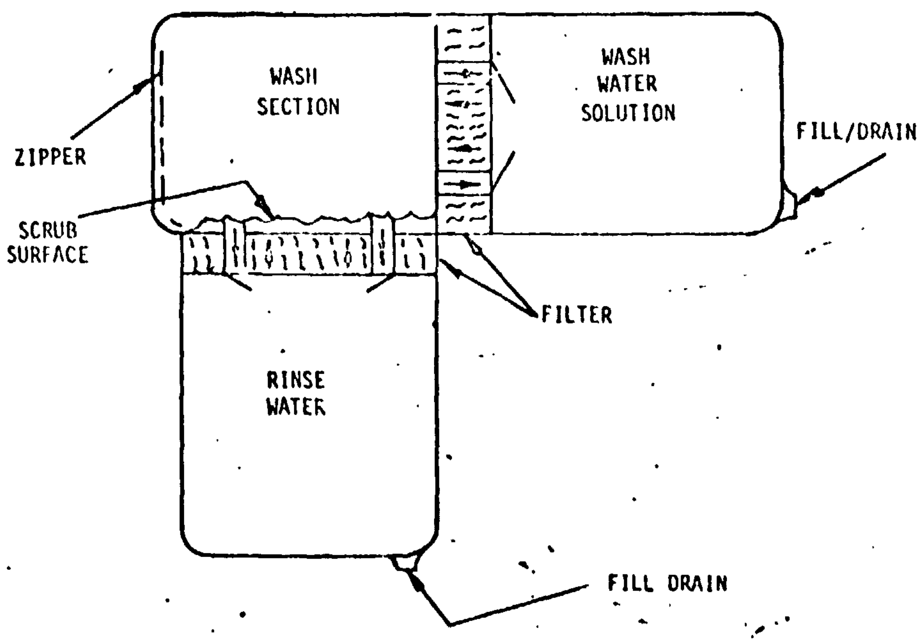
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 9/Manual Washboard

INDEX NO. 3.3.1.9 REF. NO. 90

DESCRIPTION

Due to the large amount of crew time required to manually wash clothes, this concept was not felt to be practical. However, it was included for comparison purposes with the automatic concepts. A zippered, Teflon bag is used to contain the clothes and water. The crewman manipulates the bag to achieve washing, and squeezes it to rinse and remove excess water. It was assumed that only 4.54 kg (10 lb) of wash and 4.54 kg (10 lb) of rinse water are required. It was estimated that 0.907 kg (2 lb) of water will be left in the clothes after final rinsing, over and above the amount left by the other concepts. This water is treated in the same manner as for concept #4; that is, the penalties for clothes dryer concept #1 were multiplied by 2 and added to the penalties for this clothes washing concept.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Manual washboard (Ref. #90, 41-43) INDEX NUMBER 3.3.1.9

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valves		0	55					
pump		1	20					
			75 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water heat loss (40°F)	0	800	800	0
Pump	0	69	69	0
TOTAL	0 WATT (BTU/HR)	254 (869) WATT (BTU/HR)	254 (869) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
2 times from concept	726	1350	144 AC	160	35.2
#3.3.2.1, - used to			454 DC		
dry 2 lb of water					
extra above the					
alternate concepts					
TOTAL	213 (726) WATTS/CYCLE (BTU/HR/CYCLE)	396 (1350) WATTS/CYCLE (BTU/HR/CYCLE)	144 AC 454 DC	73 (160) KG/MISSION (LB/MISSION)	1.00 (35.2) M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
[illegible]	10	[illegible]
[illegible]	[illegible]	
[illegible]	4	0.4
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]		4.5
TOTAL	23.6 ([illegible]) KG (LBS)	0.204 ([illegible]) M³ (FT³)

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SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
Detergent/ Germicide	1	.055 ([illegible])	.066	.0016 ([illegible])	.0019

Σ③ [illegible] TOTAL WT/CYCLE (LB)

Σ⑤ .0019 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT. WT/CYCLE (LB) = 11.0 ([illegible]) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT. VOL/CYCLE (FT³) = 0.020 ([illegible]) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	.10	.9291		.007
Rinse water	.10	1.000		0

Σ①

Σ④ .007

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .009 TOTAL LOST/CYCLE (Σ④) = [illegible] (LB) + [illegible] (Σ①) = 10.6 ([illegible]) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

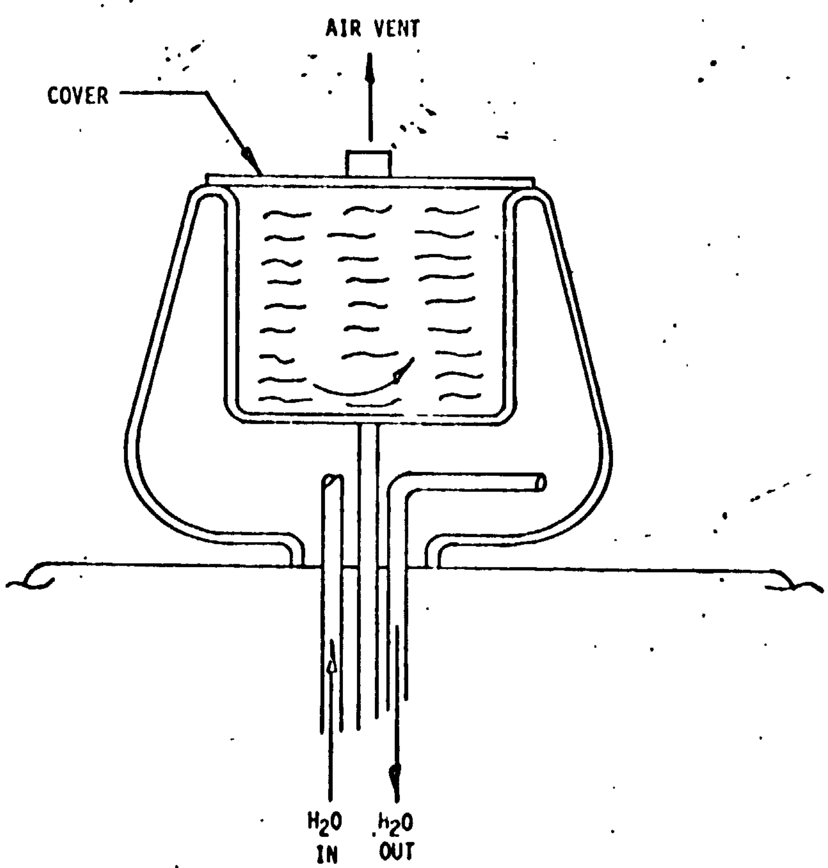
APPLIANCE FUNCTION Garment/Linen Washing

APPLIANCE CONCEPT NO./TITLE 10/Plan Recirculation

INDEX NO. 3.3.1.10 REF. NO. 90

DESCRIPTION

In this concept, water is simply recirculated through the clothes washing tub, with no means to vigorously agitate the water. Cleaning effectiveness is, therefore, relatively poor, and its adequacy would have to be proven by further testing. A spin dry cycle is used to remove the excess water after washing and rinsing.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Plain [illegible]
([illegible])

INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
[illegible]		0	[illegible]					
[illegible]		1	[illegible]					
[illegible]		1	[illegible]					
			[illegible] MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
[illegible] heat loss ([illegible])	0	44[illegible]	44[illegible]	0
Pump	0	109	109	0
Motor	0	[illegible]	[illegible]	0
TOTAL	0 WATT (BTU/HR)	1471 (5[illegible]) WATT (BTU/HR)	1471 ([illegible]) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] INDEX NUMBER 3.1.1.10

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	[illegible]	10.5
[illegible]	4	[illegible]
[illegible]	[illegible]	
[illegible]	(	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	—	[illegible]
TOTAL	90.7 ([illegible]) KG (LBS)	0.51 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent/ Germicide	1	.055 ([illegible])	.066	.0016 ([illegible])	.0019
			Σ③ [illegible] TOTAL WT/CYCLE (LB)		Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.2) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
[illegible]	55	[illegible]		.0495
[illegible]	55	1.000		0
	Σ① 110			Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE & ④ = 18.2 (LB) + 110 & ① = 58.2 (128.2) KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.3 Garment/Linen Maintenance

APPLIANCE FUNCTION 3.3.2 Garment/Linen Drying

NUMBER OF CONCEPTS CONSIDERED 9

ASSUMPTIONS

A number of references were found which present data for various clothes washer and dryer concepts (References 70, 90, 91, 100, 127, 161, 171, 185, 202, 237 and 245). These references were reviewed in detail, and the engineering data from each examined. It was soon found that much of the data did not agree. The primary reason for discrepancies was that the data were mostly very sketchy, without detailed breakdowns to define the data. For example, the clothes dryer weight in one reference would include the tub only, while another would include peripheral equipment such as heat exchanger, water separator, or other miscellaneous items. One reference was found (Ref. 90) which contained all the concepts found throughout the other reports and presented the data for each in a consistent manner for direct comparison. Therefore, it was decided to collect all the clothes washer and dryer data for this study from Reference 90.

A ground rule of two clothes washings/dryings per day was assumed from Reference 273. For this condition, and assuming a six-man Space Station crew, a detailed study of Space Station clothing usage (Reference 245) has shown a maximum laundry load of 1.66 kg (3.68 lbs). Since the clothes dryer load assumed in Reference 90 is only slightly larger than this, or 1.81 kg (4.0 lbs), the data from that reference were used directly without adjusting.

The dryers were assumed to remove 0.454 kg (1.0 lb) of residual water from the clothes, as specified in Reference 90. More testing is required to refine this assumption; however, data from Reference 202 indicate this amount of water may be too high. For most concepts, the drying time can be varied by sizing the hardware; e.g., one could choose a large heater for fast drying, or a smaller heater for slower drying. Based on the recommendation of Reference 237 and the Space Station system requirement in Reference 273, a drying time of 4 hours was assumed for these cases. Where applicable, ambient conditions are assumed to be 760 mm Hg (14.7 psia), 21.1°C (70°F) and 50 percent relative humidity. Wherever a component is connected directly to the cabin cooling circuit, it is assumed 85 percent of the energy transferred goes to the cooling circuit and 15 percent is heat leak to the cabin atmosphere.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.3.2 **** GARMENT/LINEN DRYING (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	2.000 4.000						198. (675.)	106. (363.)	72.0 227.0	.0 .0	36.3 (80.0)	.50 (17.60)	2	30	.0 (.0)
2	2.000 4.000						328. (1120.)	151. (515.)	93.0 .0	.0 .0	81.6 (180.0)	.64 (22.70)	3	65	.0 (.0)
3	2.000 4.000	2 5	.0021 (.00471) .3629 (.80001)	.00 (.001) .00 (.001)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	95. (325.)	137.0 .0	.0 .0	219.0 (471.7)	.95 (33.71)	3	60	131.2 (289.3)
4	2.000 4.000						88. (300.)	95. (325.)	137.0 101.0	.0 .0	34.9 (77.0)	.51 (17.90)	3	60	.0 (.0)
5	2.000 3.175	2 5	.0345 (.07601) .3629 (.80001)	.00 (.001) .00 (.001)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	0. (0.)	55.0 .0	.0 .0	212.7 (469.0)	.61 (21.51)	2	30	142.9 (315.0)
6	2.000 4.000	2 5	.0345 (.07601) .3629 (.80001)	.00 (.001) .00 (.001)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	13. (45.)	55.0 90.0	.0 .0	219.5 (484.0)	.64 (22.51)	2	35	142.9 (315.0)
7	2.000 4.000	2 5	.0345 (.07601) .3629 (.80001)	.00 (.001) .00 (.001)	.0 (.0) .0 (.0)	.0 (.0) .0 (.0)	0. (0.)	13. (45.)	55.0 .0	.0 .0	226.3 (499.0)	.68 (24.01)	3	70	142.9 315.0)
8	2.000 8.000						0. (0.)	46. (157.)	7.0 .0	.0 .0	22.7 (50.0)	3.68 (130.00)	1	5	.0 (.0)
9	2.000 4.000						0. (0.)	259. (883.)	3.0 256.0	.0 .0	18.1 (40.0)	3.96 (140.00)	1	10	.0 (.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1	FORCED HOT AIR-ELECTRIC
2	FORCED HOT AIR-HEAT FROM THERMAL STORAGE UNIT
3	FORCED COLD DRY AIR-DISICCANT(VACUUM REGENERABLE)
4	FORCED COLD DRY AIR-DISICCANT(ELECTRIC HEAT REGENERABLE)
5	VACUUM DRY
6	THERMAL VACUUM DRY-ELECTRIC HEAT
7	THERMAL VACUUM DRY,THERMAL STORAGE/RADIANT HEAT
8	CLOTHES LINE-FORCED CONVECTION
9	CLOTHES LINE-FORCED CONVECTION-ELECTRIC HEAT

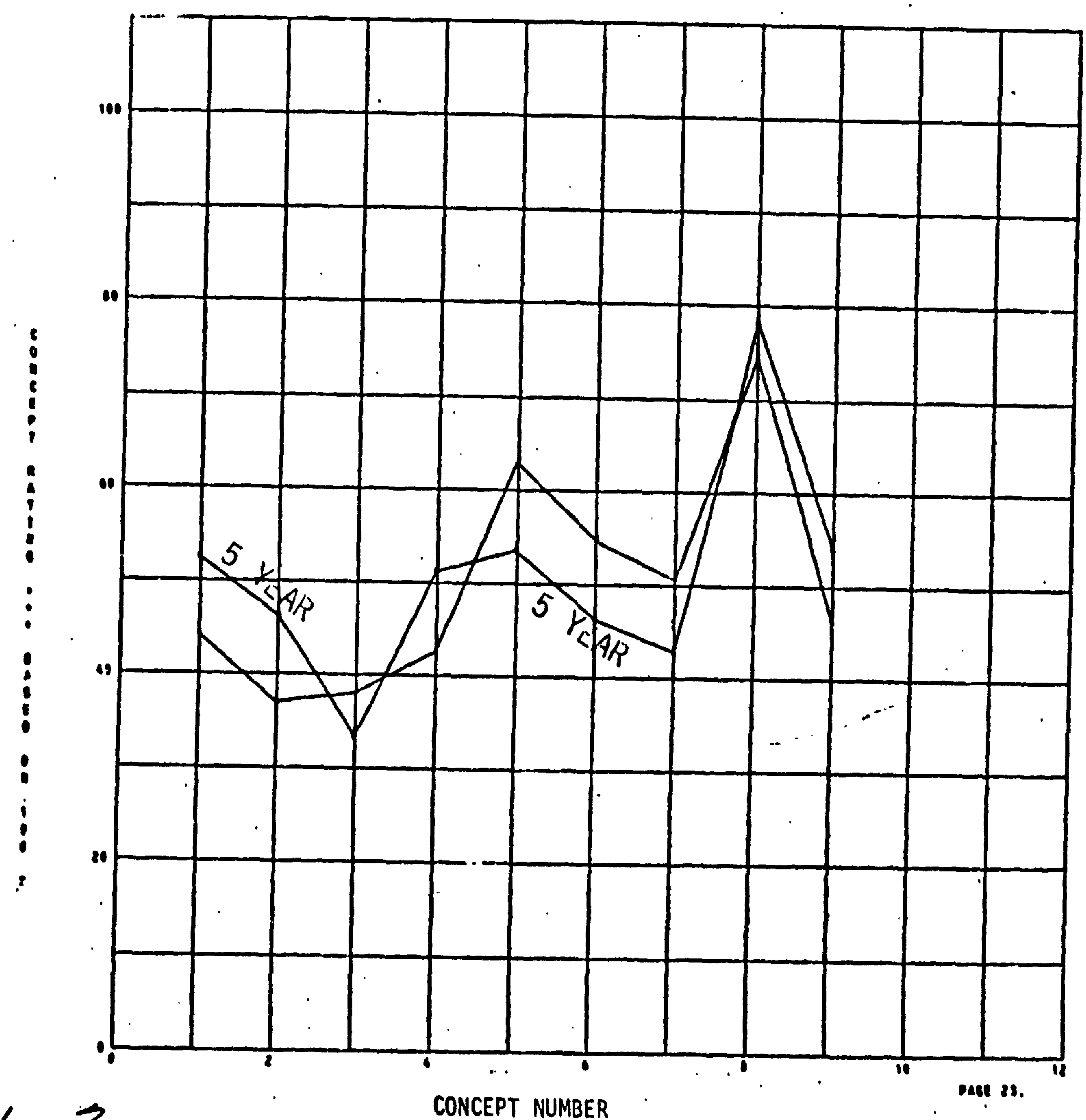
(*)

1	CABIN AIR	(CIRCULATED),	LITERS/SEC	(FT^3/MIN)
2	CABIN AIR	(LOST),	KG/HR	(LB/HR)
3	OXYGEN	(LOST)	KG/HR	(LB/HR)
4	COOLING WATER	(CIRCULATED),	KG/HR	(LB/HR)
5	WATER	(LOST)	KG/HR	(LB/HR)
6	NITROGEN	(CIRCULATED),	KG/HR	(LB/HR)
7	NITROGEN	(USED),	KG/HR	(LB/HR)
8	FREON	(CIRCULATED),	KG/HR	(LB/HR)
9	WATER	(PROCESSED),	KG/HR	(LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

73323

APPLIANCE CONCEPT NO.		CONCEPT NAME
1	-	FORCED HOT AIR-ELECTRIC
2	-	FORCED HOT AIR-HEAT FROM THERMAL STORAGE UNIT
3	-	FORCED COLD DRY AIR-DISICCANT(VACUUM REGENERABLE)
4	-	FORCED COLD DRY AIR-DISICCANT(ELECTRIC HEAT REGENERABLE)
5	-	VACUUM DRY
6	-	THERMAL VACUUM DRY-ELECTRIC HEAT
7.	-	THERMAL VACUUM DRY-THERMAL STORAGE/RADIANT HEAT
8	-	CLOTHES LINE-FORCED CONVECTION
9	-	CLOTHES LINE-FORCED CONVECTION+ELECTRIC HEAT



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L-3

Garment/Linen Drying (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 2
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - - GARMENT/LINEN DRYING (SPACE STATION)
(09/15/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9
WEIGHT	40.000	499.00	15	12.60	9.59	.82	12.69	.90	.45	.00	13.50	13.80
POWER	4.9700	185.28	15	.00	9.65	7.13	2.29	11.84	7.53	11.84	14.60	2.58
VOLUME	17.600	140.00	10	8.74	8.38	7.59	8.72	8.46	8.39	8.28	.71	.00
THERMAL	.00000	126.40	15	5.16	.00	10.06	8.14	15.00	14.32	14.32	12.62	1.59
RELIAB-Y	.96519	.99631	5	.67	.82	.83	.48	4.47	4.13	4.29	.00	2.28
MAINTENC	.99999	1.00000	5	.20	.27	.39	.00	4.33	4.17	4.25	2.87	2.71
SAFETY	.00000	3.0000	5	1.67	1.67	3.33	1.67	.00	.00	.00	5.00	3.33
DEV COST	5.0000	70.000	15	8.57	1.07	2.14	2.14	8.57	7.50	.00	13.93	12.86
TOTAL PT	.00000	85.000	85	37.60	31.46	32.30	36.13	53.58	46.49	42.97	63.23	39.14
RATING	.00000	100.00	100	44.24	37.01	38.00	42.51	63.04	54.70	50.56	74.38	46.05

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	44.24	37.01	38.00	42.51	63.04	54.70	50.56	74.38	46.05
WEIGHT	47.46	39.19	35.36	45.92	58.41	50.50	46.46	75.65	49.77
POWER	40.65	39.23	38.77	40.30	64.32	54.33	52.86	76.24	43.71
VOLUME	46.64	39.61	40.10	44.99	64.24	56.32	52.35	70.65	43.4[illegible]
THERMAL	43.44	34.01	40.36	43.46	66.03	58.00	54.20	75.17	43.17
RELIAB-Y	43.36	36.42	37.38	41.57	63.79	55.49	51.56	72.26	46.03
MAINTENC	43.09	36.11	37.14	41.29	63.71	55.52	51.54	73.90	46.28
SAFETY	43.93	36.90	38.82	42.25	61.24	53.13	49.11	75.11	46.63
DEV COST	45.29	34.59	36.07	40.22	62.56	54.32	46.46	75.88	49.26

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	44.24	37.01	38.00	42.51	63.04	54.70	50.56	74.38	46.05
WEIGHT	40.39	34.90	41.14	38.44	68.55	59.70	55.45	72.87	41.60
POWER	48.52	34.36	37.08	45.14	61.50	55.13	47.81	72.16	48.84
VOLUME	41.54	34.08	35.63	39.72	61.69	52.87	48.54	78.59	48.92
THERMAL	45.19	40.59	35.18	41.37	59.46	50.75	46.21	73.44	49.48
RELIAB-Y	45.17	37.63	38.65	43.50	62.24	53.85	49.49	76.64	46.06
MAINTENC	45.46	37.96	38.91	43.80	62.32	53.83	49.52	74.90	45.80
SAFETY	44.57	37.12	37.13	42.79	64.95	56.35	52.09	73.61	45.42
DEV COST	42.99	39.90	40.29	45.24	63.61	55.15	55.45	72.60	42.21

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	52.51	46.35	33.41	51.06	53.50	46.37	42.87	78.23	53.94
WEIGHT	54.71	47.58	31.47	53.40	50.19	43.35	39.88	79.05	56.59
POWER	48.85	47.61	34.40	48.57	55.28	46.64	45.39	79.56	51.38
VOLUME	54.18	48.13	35.44	52.79	54.98	48.16	44.77	74.84	51.37
THERMAL	51.25	43.12	35.76	51.29	56.75	49.80	46.54	78.64	50.91
RELIAB-Y	51.51	45.57	32.95	50.02	54.34	47.20	43.87	76.32	53.64
MAINTENC	51.33	45.35	32.79	49.82	54.31	47.28	43.90	77.72	53.95
SAFETY	52.05	46.03	34.23	50.63	52.20	45.24	41.83	78.76	54.25
DEV COST	52.84	43.61	32.08	48.50	53.76	46.62	39.88	79.25	56.16
REC COST	55.83	50.09	31.65	54.48	49.77	43.14	39.88	79.74	57.15

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	52.51	46.35	33.41	51.06	53.50	46.37	42.87	78.23	53.94
WEIGHT	49.96	44.92	35.68	48.35	57.35	49.89	46.35	77.27	50.85
POWER	56.77	44.89	32.27	53.97	51.44	46.06	39.95	76.68	56.92
VOLUME	50.68	44.38	31.18	49.16	51.86	44.40	40.77	81.97	56.78
THERMAL	53.98	50.11	30.68	50.80	49.73	42.39	38.61	77.75	57.45
RELIAB-Y	53.56	47.17	33.90	52.16	52.62	45.50	41.82	80.23	54.26
MAINTENC	53.76	47.40	34.07	52.37	52.65	45.42	41.79	78.76	53.93
SAFETY	53.00	46.68	32.56	51.52	54.87	47.56	43.97	77.67	53.61
DEV COST	52.14	49.53	34.97	54.05	53.21	46.08	46.35	77.04	51.36
REC COST	48.66	42.00	35.46	47.10	57.84	50.13	46.35	76.46	50.20

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 2
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX * * * * * GARMENT/LINEN DRYING (SPACE STATION)
(04/16/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9
WEIGHT	40.000	499.00	15	12.60	9.59	.82	12.69	.90	.45	.00	13.50	13.80
POWER	4.9700	185.28	15	.00	9.65	7.13	2.29	11.84	7.53	11.84	14.60	2.58
VOLUME	17.600	140.00	10	8.74	8.38	7.59	8.72	8.46	8.39	8.28	.71	.0C
THERMAL	.00000	126.40	15	5.16	.00	10.06	8.14	15.00	14.32	14.32	12.62	1.59
RELIAB-Y	.69772	.96324	5	.58	.72	.72	.42	4.39	4.01	4.18	.00	2.08
MAINTENC	.99999	1.00000	5	.20	.27	.39	.00	4.33	4.17	4.25	2.87	2.71
SAFETY	.00000	3.0000	5	1.67	1.67	3.33	1.67	.00	.00	.00	5.00	3.33
DEV COST	5.0000	70.000	15	8.57	1.07	2.14	2.14	8.57	7.50	.00	13.93	12.86
REC COST	.00000	315.00	15	15.00	15.00	1.23	15.00	.00	.00	.00	15.00	15.00
TOTAL PT	.00000	100.00	100	52.51	46.35	33.41	51.06	53.50	46.37	42.87	78.23	53.94
RATING	.00000	100.00	100	52.51	46.35	33.41	51.06	53.50	46.37	42.87	78.23	53.94

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.3.2-GARMENT/LINEN DRYING

APPLIANCE TYPE \ COMPONENT TYPE	MOTOR	ACCUMULATOR	WATER SEPARATOR	HEAT EXCHANGER	HEATER DC	BLOWER AIR	FILTER	TRANSMISSION (GEAR BOX)	CONTROLLER TIMER	THERMAL STORAGE UNIT	VALVE	DESICCANT CANISTER					NUMBER OF SAFETY CRITICAL ITEMS
NO.	1	4	6	16	17	18	9	7	19	20	3	21					
FORCED HOT AIR-ELECTRIC (pg. 51)	1	1	1	1	1	1	1	1	1	-	-	-					2
FORCED HOT AIR-HEAT FROM THERMAL STORAGE UNIT (pg. 55)	1	1	1	1	-	1	1	1	1	1	-	-					2
FORCED COLD DRY AIR-DESICCANT-VACUUM REGENERABLE (pg. 58)	1	1	-	-	-	1	1	1	1	-	2	1					1
FORCED COLD DRY AIR-DESICCANT ELECTRIC HEAT REGENERATION (pg. 61)	1	1	1	1	1	1	1	1	1	-	1	1					2
VACUUM DRY (pg. 64)	-	1	-	-	-	-	-	-	1	-	1	-					3
THERMAL VACUUM DRY-ELECTRIC HEAT (pg. 66)	-	1	-	-	1	-	-	-	1	-	1	-					3
THERMAL/VACUUM DRY-THERMAL STORAGE/RADIANT HEAT (pg. 68)	-	1	-	-	-	-	-	-	1	1	1	-					3
CLOTHES LINE-FORCED CONVECTION (pg. 72)	-	-	1	1	-	1	-	-	-	-	-	-					0
CLOTHES LINE-FORCED CONVECTION + ELECTRIC HEAT (pg. 74)	-	-	1	1	1	1	-	-	-	-	-	-					1

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

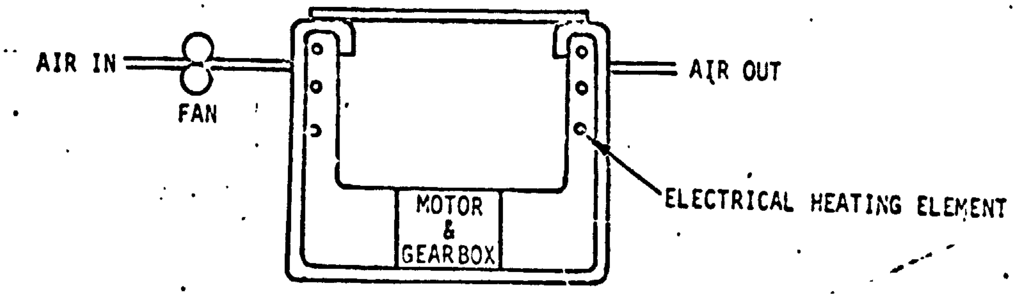
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 1/Forced Hot Air - Electric

INDEX NO. 3.3.2.1 REF. NO. 90

DESCRIPTION

In this concept, a jet of air spray at 60°C (140°F) is directed into the clothes from outside the drum. The clothes are contained in a wire mesh drum which is rotated slowly in a direction counter to the air inlet. A prototype clothes dryer using this concept is described in Reference 237.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT forced hot air electric (Ref # 90 p. 51-54) INDEX NUMBER 3.3.2.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Motor	4	62					
Fan	4	10					
Heater	4				227		
		72 MAXIMUM		TOTAL	227 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Motor	0	[illegible]	[illegible]	0
Fan	0	[illegible]	[illegible]	0
Heater/water	265	[illegible]	117	[illegible]
TOTAL	77.6 (265) WATT (BTU/HR)	226 ([illegible]) WATT (BTU/HR)	106 ([illegible]) WATT (BTU/HR)	198 (675) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] - electric (Ref.# [illegible]) INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
Dryer	[illegible]	[illegible]
[illegible] (condensing H/X, water separator and packaging)	[illegible]	[illegible]
TOTAL	36.3 [illegible]	0.50 [illegible]
	KG (LBS)	M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ ______ TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.VOL/CYCLE (FT³) = ______ M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (≈ ④) = ______ (LB) + ______ (≈ ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

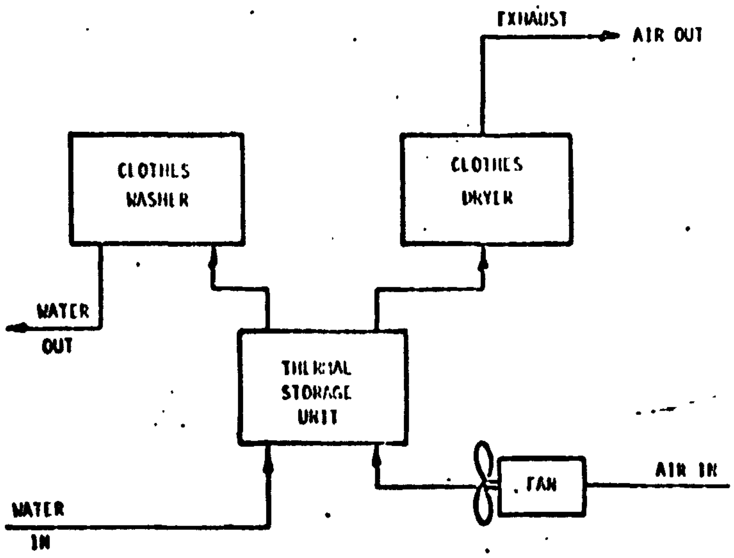
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 2/Forced Hot Air - Thermal Storage

INDEX NO. 3.3.2.2 REF. NO. 90

DESCRIPTION

This dryer concept is the same as Concept 1 except the electrical heater is replaced by a thermal storage unit which utilizes waste heat from the wash/rinse cycle. This concept should receive a credit for cooling the clothes washer water; however, this has been neglected. Clothes are dried by air at 49°C (120°F) from the thermal storage unit directed into the slowly revolving wire mesh drum.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Feed hot air – thermal storage (Ref. #90, TC-57)   INDEX NUMBER 3.3.2.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑥
Motor		4	62					
Fan		4	31					
			93 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Motor	0	212	212	0
Fan	0	105	105	0
Water/thermal storage	265	1053	198	[illegible]
TOTAL	77.6 (265) WATT (BTU/HR)	401 (1370) WATT (BTU/HR)	151 (515) WATT (BTU/HR)	328 (1120) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] - thermal [illegible] ([illegible]) INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible] (condensing		
H/X, water separator,		
packaging)		
TOTAL	81.6 ([illegible]) KG (LBS)	0.64 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ ______ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.VOL/CYCLE (FT^3) = ______ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ④) + ______ (LB) + ______ (Σ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

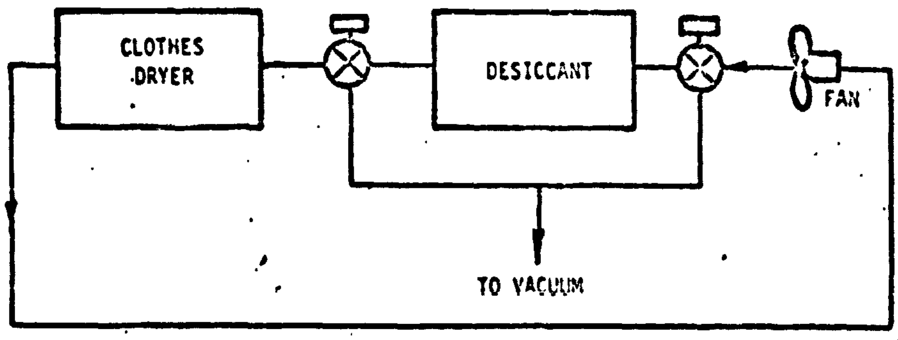
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 3/Forced Cold Dry Air-Desiccant-Vacuum Regenerable

INDEX NO. 3.3.2.3 REF. NO. 90

DESCRIPTION

In this concept, a closed loop of air circulates through a silica gel desiccant bed, where it is dried, and then through the clothes dryer tub where it dries the clothes. After the clothes are dried, space vacuum is used to dry the desiccant. The fan size is selected based on a 4-hour clothes drying time, and 4 hours are assumed for desiccant vacuum regeneration.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Forced cold dry air - desiccant - vacuum regenerable (Ref. #90 p[illegible]) INDEX NUMBER 3.1.2.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Motor	4	60					
Valve	0	55					
Fan	4	20					
		137 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

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THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Motor	0	212	212	0
Fan	0	68	68	0
Desiccant bed	0	45	45	0
TOTAL	0 WATT (BTU/HR)	95.2 (325) WATT (BTU/HR)	95.2 (325) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
Tankage due to lost air, water	0	0	0	104	9.6
TOTAL	0 WATTS/CYCLE (BTU/HR/CYCLE)	0 WATTS/CYCLE (BTU/HR/CYCLE)	0	47.2 (104) KG/MISSION (LB/MISSION)	0.272 (9.6) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Forced cold dry air - desiccant - vacuum regenerable (Ref.#90 p 55-60)   INDEX NUMBER 3.3.2.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
Dryer		40	
Desiccant bed		[illegible]	
[illegible]		[illegible]	
Valves		[illegible]	
TOTAL		32.7 ([illegible]) KG (LBS)	0.55 ([illegible]) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB)   Σ⑤ ______ TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.VOL/CYCLE (FT³) = ______ M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Air lost to space	0.0046			
Water lost to space	0.80			

Σ① ______   Σ④ ______

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = 134 (276) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

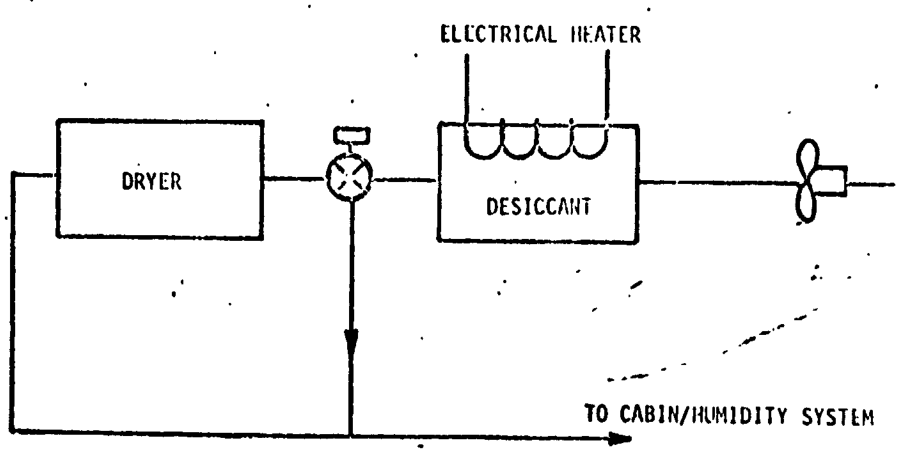
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 4/Forced Cold Air-Desiccant-Heat Regenerable

INDEX NO. 3.3.2.4 REF. NO. 90

DESCRIPTION

This concept is identical to Concept 3 except that the desiccant is regenerated by an electrical heater instead of vacuum.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible] - desiccant - heat regenerable INDEX NUMBER [illegible]

(Ref. #90 p. 61-62)

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME / CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①X⑦
Valves	0	55					
Motor	4	62					
Fan	8	20					
Heater	4				101		
		137 MAXIMUM		TOTAL	101 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Motor	0	212	212	0
Fan	0	68	68	0
Heater [illegible]	[illegible]	80	45	[illegible]
TOTAL	77.6 (265) WATT (BTU/HR)	105 ([illegible]) WATT (BTU/HR)	95 ([illegible]) WATT (BTU/HR)	88 ([illegible]) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] dry air - desiccant - heat regenerable (Ref. #90 p 61-62) INDEX NUMBER 3.3.2.4

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
[illegible]	40	
[illegible] bed	20	
[illegible]	10	
[illegible]	2	
[illegible]	5	
TOTAL	34.9 (77) KG (LBS)	0.51 (17.9) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①X② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①X④ (FT³)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ ______ TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.VOL/CYCLE (FT³) = ______ M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①X② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ ④) = ______ (LB) + ______ (Σ ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

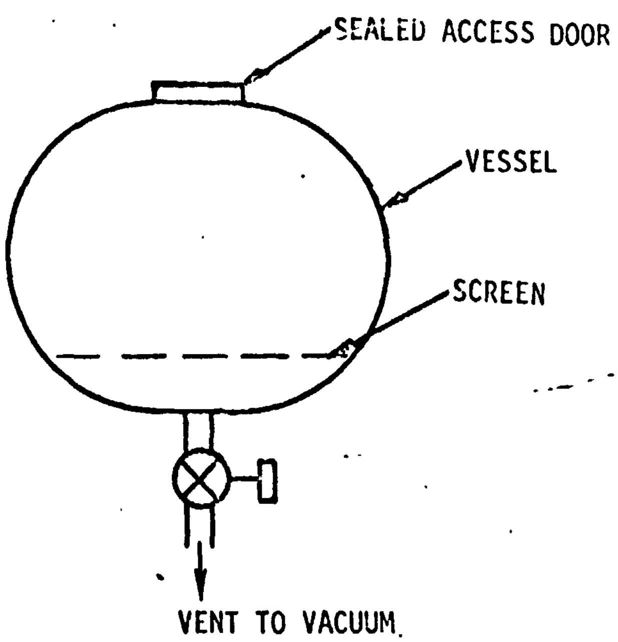
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 5/Vacuum Dry

INDEX NO. 3.3.2.5 REF. NO. 90

DESCRIPTION

In this concept, clothes are simply sealed in a tub which is vented to space vacuum. The water will first freeze due to rapid evaporation, after which the ice will gradually sublime from the heat of conduction and radiation through the structural walls. Drying time is assumed, according to Reference 90, to be 6.35 hours.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Vacuum dry (Ref.# 90 p 64, 65)

INDEX NUMBER 2.3.2.5

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	③ AVERAGE (WATTS)	④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	⑥ AVERAGE (WATTS)	⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valves	0	55					
		55 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
Tankage due to lost air, water	0	0	0	106	9.8
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		48.1 (106) KG/MISSION (LB/MISSION)	0.278 (9.8) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Vacuum dry (Ref. #90 p 64, 66) INDEX NUMBER 3.3.2.5

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]		40	
Valve		1	
TOTAL		18.6 (41) KG (LBS)	0.20 (7) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					
		Σ③	TOTAL WT/CYCLE (LB)	Σ⑤	TOTAL VOL/CYCLE (FT^3)

TOTAL WT. / MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT. WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL / MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT. VOL/CYCLE (FT^3) = ______ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Air lost to space	0.076			
Water lost to space	0.80			
Σ①			Σ④	

TOTAL WT. / MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = 146 (322) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

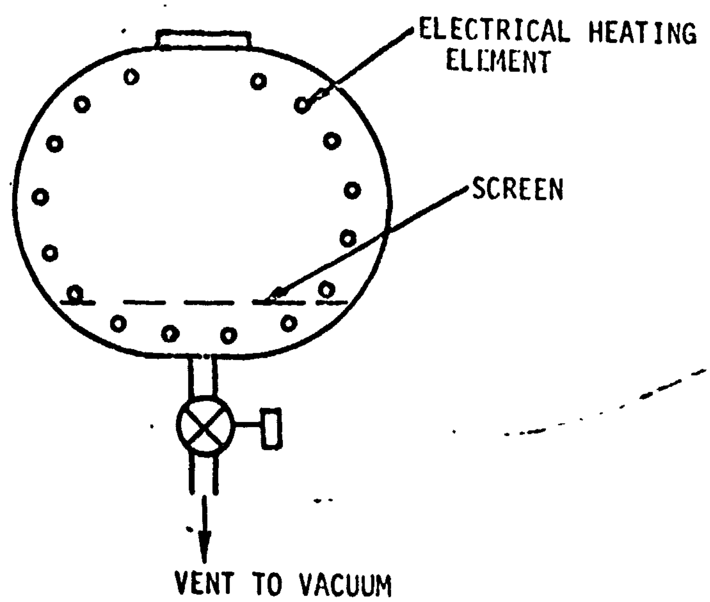
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 6-Thermal Vacuum Dry - Electric Heat

INDEX NO. 3.3.2.6 REF. NO. 90

DESCRIPTION

This concept is identical to Concept 5 except that an electrical heater has been added to provide additional heat to aid the sublimation process. Heater size was based on a drying time of 4 hours to be consistent with the other concepts.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Thermal vacuum dry - electric heat (Ref #90 p 66, 67)

INDEX NUMBER 2.3.2.6

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valve		0	55					
Heater		4				90		
			55 MAXIMUM		TOTAL	90 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Heater	0	45	45	0
TOTAL	0	13.2 (45)	13.2 (45)	0
	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
Tankage due to lost air, water	0	0	0	106	9.8
TOTAL	0	0	0	48.1 (106)	0.278 (9.8)
	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Thermal vacuum dry - electric INDEX NUMBER 3.3.2.6

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Dryer	55	8
Valve	1	
TOTAL	25.4 (56) KG (LBS)	0.23 (8) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB) Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = CYCLES/DAY x DAYS/MISSION x TOT.WT/CYCLE (LB) = KG (LB)

TOTAL VOL MISSION = CYCLES/DAY x DAYS/MISSION x TOT.VOL/CYCLE (FT^3) = M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Air lost to space	0.076			
Water lost to space	0.80			

Σ① Σ④

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x TOTAL LOST/CYCLE (Σ.④) = (LB) + (Σ ①) = 146 (322) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

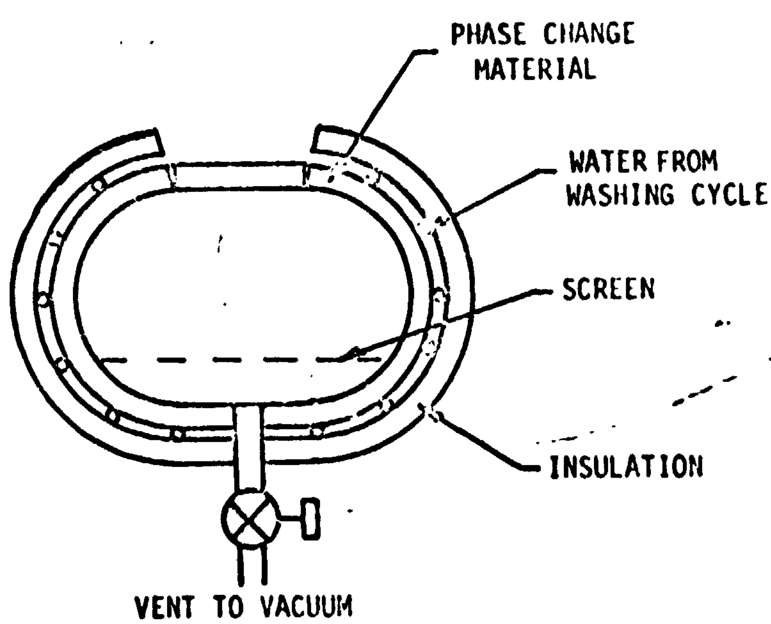
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 7/Thermal Vacuum Dry-Thermal Storage-Radiant Heat

INDEX NO. 3.3.2.7 REF. NO. 90

DESCRIPTION

This concept is identical to Concept 6 except that the electrical heater is replaced by a thermal storage unit which stores the heat from the wash and rinse water. Clothes are sealed in a tub which is vented to space vacuum, and the energy required for sublimation provided by the thermal storage unit. A drying time of 4 hours was assumed.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Thermal vacuum dry - thermal storage - [illegible] INDEX NUMBER 2.3.2.7
(ref #90 p 68.2)

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valve		2	55					
			55 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Thermal storage unit	0	45	45	0
TOTAL	0 WATT (BTU/HR)	13.2 (45) WATT (BTU/HR)	13.2 (45) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
Tankage due to hot air, water	0	0	0	106	9.8
TOTAL	0 WATTS/CYCLE (BTU/HR/CYCLE)	0 WATTS/CYCLE (BTU/HR/CYCLE)	0	48.1 (106) KG/MISSION (LB/MISSION)	0.278 (9.8) M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT thermal vacuum dry - thermal storage - radiant heat INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Drum	[illegible]	
Valve	[illegible]	
TOTAL	32.2 (71) KG (LBS)	0.269 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ ____ TOTAL WT/CYCLE (LB) Σ⑤ ____ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Air lost to space	0.076			
Water lost to space	0.[illegible]0			

Σ① ____ Σ④ ____

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x TOTAL LOST/CYCLE α ③ = ____ (LB) + ____ α ① = 146 (322) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

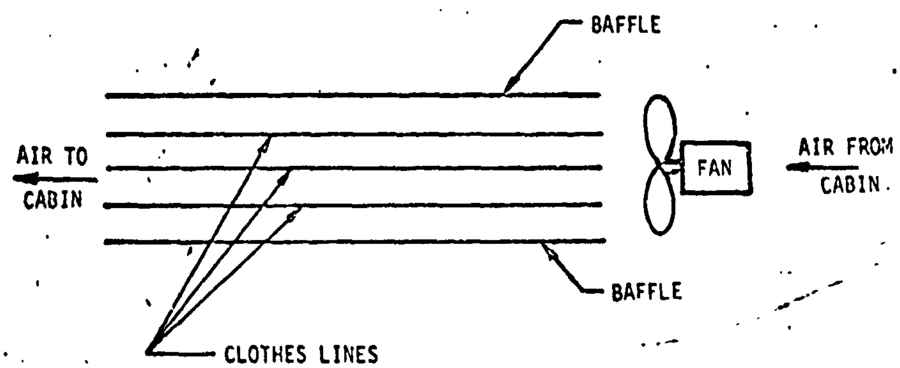
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 8/Clothesline-Forced Convection

INDEX NO. 3.3.2.8 REF. NO. 90

DESCRIPTION

In this concept, clothes are attached (with pins, snaps, velcro, etc.) to wide mesh screen panels which are stacked in parallel racks. A fan is used to force air between the panels to dry the clothes. Crew time would be relatively high compared with the other concepts. Drying time was assumed to be 8 hours.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Clothes Dryer - Forced convection (Ref #90 p 72,73)   INDEX NUMBER 2.3.2.8

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Fan	8	7					
		7 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Fan	0	24	24	0
Water	133	—	133	0
TOTAL	39.0 (133) WATT (BTU/HR)	7.0 (24) WATT (BTU/HR)	46.0 (157) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Clothes line - Forced convection INDEX NUMBER 3.2.[illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Dryer	25	130
Fan	[illegible]	
TOTAL	22.7 (5[illegible]) KG (LBS)	3.68 (1[illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB) Σ⑤ ______ TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL/MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT.VOL/CYCLE (FT^3) = ______ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ______ Σ④ ______

TOTAL WT./MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = ______ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

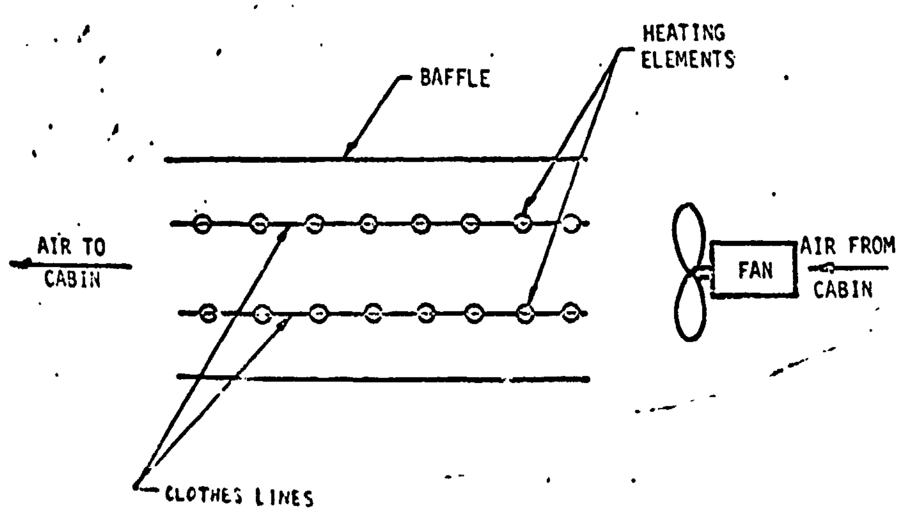
APPLIANCE FUNCTION Garment/Linen Drying

APPLIANCE CONCEPT NO./TITLE 9/Clothesline-Forced Convection plus Electric Heat

INDEX NO. 3.3.2.9 REF. NO. 90

DESCRIPTION

This concept is identical to Concept 8 except that an electrical heating element has been added within the clothes panels to expedite the drying process. Heater size is based on a drying time of 4 hours.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Clothesline - forced convection plus electric heat (Ref. # 92 p 74,75)   INDEX NUMBER 3.[illegible].[illegible].9

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①X⑦
Fan		4	3					
Heater		4				[illegible]		
			3 MAXIMUM		TOTAL	[illegible] MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Fan	0	10	10	0
Heater / [illegible]	265	608	[illegible]	0
TOTAL	77.6 (265) WATT (BTU/HR)	181 (618) WATT (BTU/HR)	259 ([illegible]) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS. (CONCLUDED)

CONCEPT [illegible] forced convection plus electric heat   INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
Dryer		[illegible]	140
Fan		5	
TOTAL		18.1 ([illegible]) KG (LBS)	3.96 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ① x ② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ① x ④ (FT^3)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB)   Σ⑤ ______ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT. WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY x ______ DAYS/MISSION x ______ TOT. VOL/CYCLE (FT^3) = ______ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ① x ② (LB)	④ AMT LOST/CYCLE ① - ③ (LB)
N/A				

Σ① ______   Σ④ ______

TOTAL WT. MISSION = ______ CYCLE/DAY x ______ DAYS/MISSION x ______ TOTAL LOST/CYCLE (Σ ④) = ______ (LB) + ______ (Σ ①) = ______ KG (LB)

HABITABILITY SUBSYSTEM 3.0 Housekeeping

HABITABILITY FUNCTION 3.3 Garment/Linen Maintenance

APPLIANCE FUNCTION 3.3.3 Garment/Linen Washer/Dryer-Disposable Clothes

NUMBER OF CONCEPTS CONSIDERED 9

ASSUMPTIONS

For this appliance function, the most promising individual clothes washer concepts (Section 4.3.1) were combined with the most promising clothes dryer (Section 4.3.2) to form integrated clothes washer/dryer units. The data for each case were taken directly from the data sheets for Section 4.3.1 and 4.3.2. Washer and dryer data were combined, and the redundant components eliminated. Peak power and thermal requirements were taken to be the maximum for the individual washer and dryer, rather than the sum of the two, since each is operated at separate times.

The washer/dryer combinations were compared with disposable clothes. Clothes wear rates and weights assumed with a washer/dryer were taken from Reference 237 and 245 and are shown in Table C2-7. A clothes weight packaging factor of 1.31, and clothes packaged volume, ere taken from Reference 100. This resulted in a total clothes/linens size of 61.2 kg (135 lbs) and 0.725 cu m (25.6 cu ft) required for a six-man crew with an automatic clothes washer/dryer. The clothes required for the disposable case were computed from a wear rate of 2.88 kg (6.366 lbs) per day, with the volume again taken from Reference 100.

TABLE C2-7 CLOTHES/LINENS USAGE RATES ASSUMED PER MAN WITH A CLOTHES WASHER/DRYER AVAILABLE

ITEM	WEAR INTERVAL	NUMBER	ARTICLE WEIGHT kg	ARTICLE WEIGHT lb	TOTAL WEIGHT kg	TOTAL WEIGHT lb
Short sleeve shirt	3 days	4	0.20	0.45	0.82	1.80
Trousers	7 days	3	.54	1.20	1.63	3.60
Jacket	7 days	3	.50	1.10	1.50	3.30
Undershorts/sox/shirt	2 days	6	.26	.57	1.55	3.42
Shoes (pr.)		3	.31	.69	.94	2.07
Gloves	21 days	3	.08	.17	.23	.51
Towels	1 day	7	.10	.23	.73	1.61
Washcloth	.5 day	12	.035	.077	.42	.92
Total			2.035	4.50	7.82	17.23

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 3.3.3.... GARMENT/LINEN WASHER/DRYER-DISPOSABLE CLOTHES (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIA)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	198. (675.)	1470. (5020.)	237.0 227.0	.0 .0	236.1 (520.5)	1.32 (46.75)	3	60	18.9 (41.6)
2	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	328. (1120.)	1470. (5020.)	237.0 .0	.0 .0	283.7 (625.5)	1.68 (59.45)	3	65	18.9 (41.6)
3	2.000 9.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 .0	.0 .0	328.2 (723.5)	5.01 (176.75)	3	70	18.9 (41.6)
4	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 256.0	.0 .0	323.6 (713.5)	5.29 (186.75)	3	60	18.9 (41.6)
5	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	198. (675.)	1470. (5020.)	237.0 227.0	.0 .0	239.3 (527.5)	1.31 (46.25)	2	90	18.9 (41.6)
6	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	328. (1120.)	1470. (5020.)	237.0 .0	.0 .0	286.9 (632.5)	1.66 (58.45)	3	65	18.9 (41.6)
7	2.000 9.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 .0	.0 .0	243.8 (537.5)	4.99 (176.25)	3	70	18.9 (41.6)
8	2.000 5.000	9	49.8960 (110.0000)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	1470. (5020.)	237.0 256.0	.0 .0	239.3 (527.5)	5.27 (186.15)	2	90	18.9 (41.6)
9	.000 .000						0. (0.)	0. (0.)	.0 .0	.0 .0	693.6 (1529.0)	8.21 (290.00)	1	0	678.6 (1496.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	FLUIDIC AGITATION/FORCED HOT AIR-ELECTRIC HEATER
2 -	FLUIDIC AGITATION/FORCED HOT AIR-THERMAL STORAGE HEATER
3 -	FLUIDIC AGITATION/FORCED AIR DRYING-CLOTHES LINE
4 -	FLUIDIC AGITATION/FORCED AIR DRYING-CLOTHES LINE
5 -	WATER SPRAY AGITATION/FORCED HOT AIR-ELECTRIC HEATER
6 -	WATER SPRAY AGITATION/FORCED HOT AIR-THERMAL STORAGE HEATER
7 -	WATER SPRAY AGITATION/FORCED AIR DRYING-CLOTHES LINE
8 -	WATER SPRAY AGITATION/ELECTRICALLY HEATED-CLOTHES LINE
9 -	DISPOSABLE CLOTHES

(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST), KG/HR (LB/HR)
3 - OXYGEN (LOST), KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST), KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED), KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED), KG/HR (LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

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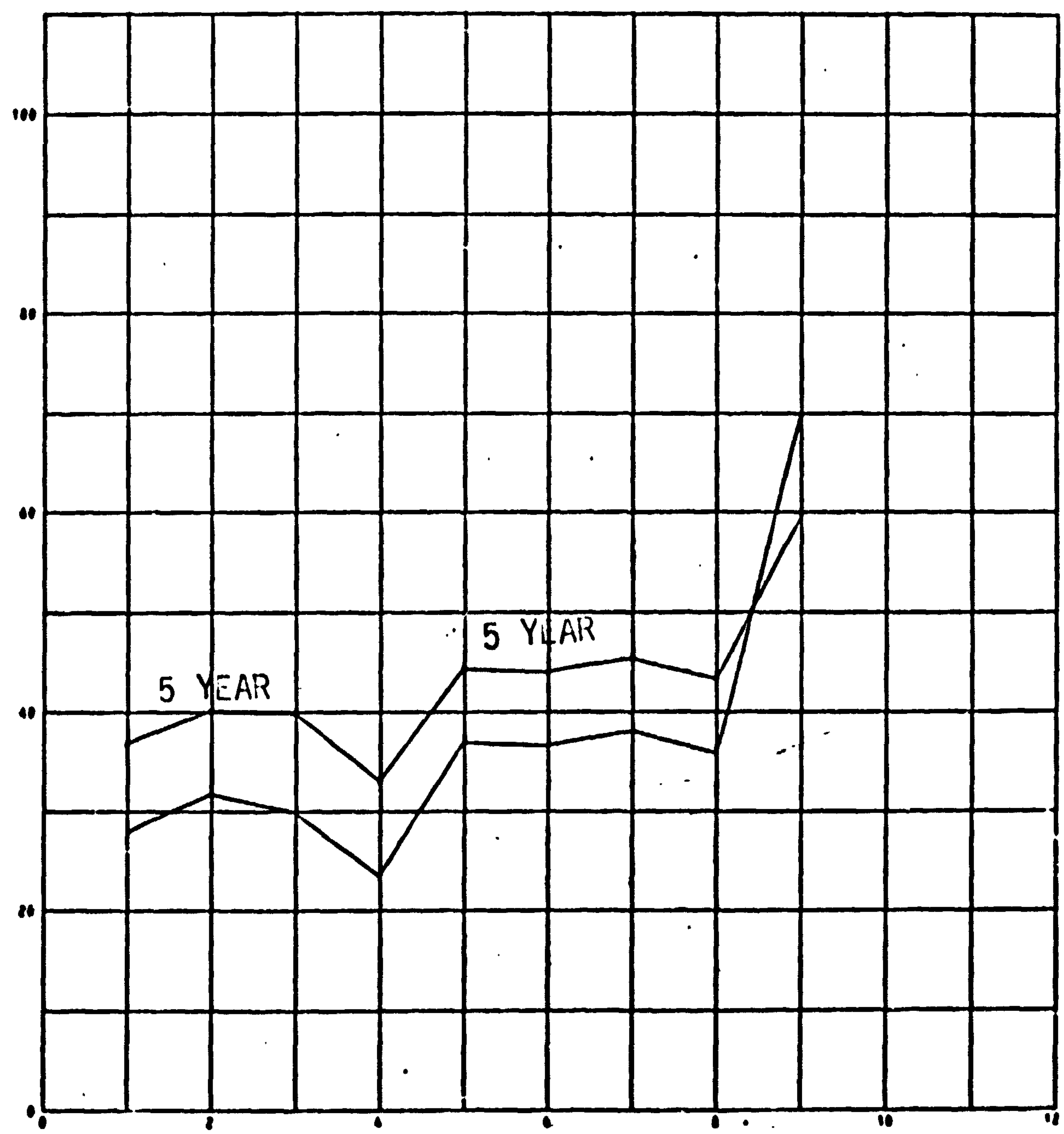
APPLIANCE CONCEPT NO.		CONCEPT NAME
1	=	FLUIDIC AGITATION/FORCED HOT AIR-ELECTRIC HEATER
2	=	FLUIDIC AGITATION/FORCED HOT AIR-THERMAL STORAGE HEATER
3	=	FLUIDIC AGITATION/FORCED AIR DRYING-CLOTHES LINE
4	=	FLUIDIC AGITATION/FORCED AIR DRYING-CLOTHES LINE
5	=	WATER SPRAY AGITATION/FORCED HOT AIR-ELECTRIC HEATER
6	=	WATER SPRAY AGITATION/FORCED HOT AIR-THERMAL STORAGE HEATER
7	=	WATER SPRAY AGITATION/FORCED AIR DRYING-CLOTHES LINE
8	=	WATER SPRAY AGITATION/ELECTRICALLY HEATED-CLOTHES LINE
9	=	DISPOSABLE CLOTHES



CONCEPT NUMBER

Garment/Linen Washer/Dryer-Disposable Clothes (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 17
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - - GARMENT/LINEN WASHER/DRYER-DISPOSABLE CLOTHES (SPACE STATION)
(04/16/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9
WEIGHT	520.50	1529.0	15	9.89	8.86	7.90	8.00	9.83	8.79	9.73	9.83	.00
POWER	.00000	319.57	15	.80	7.10	7.10	.00	.80	7.10	7.10	.00	15.00
VOLUME	46.259	290.00	10	8.39	7.95	3.91	3.56	8.41	7.98	3.92	3.58	.00
THERMAL	.00000	703.04	15	.51	.00	1.29	1.29	.51	.00	1.29	1.29	15.00
RELIAB-Y	.71158	1.0000	5	1.89	1.91	.00	2.09	3.03	3.24	2.20	3.47	5.00
MAINTENC	.99994	.99999	5	.00	.03	.19	.39	2.45	2.91	3.10	3.30	4.54
SAFETY	.00000	2.0000	5	.00	.00	5.00	2.50	.00	.00	5.00	2.50	5.00
DEV COST	.00000	70.000	15	2.14	1.07	.00	2.14	6.43	1.07	.00	6.43	15.00
TOTAL PT	.00000	85.000	85	23.63	26.92	25.39	19.98	31.45	31.10	32.34	30.39	59.54
RATING	.00000	100.00	100	27.80	31.67	29.87	23.50	37.01	36.59	38.05	35.75	70.05

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	27.80	31.67	29.87	23.50	37.01	36.59	38.05	35.75	70.05
WEIGHT	30.89	33.90	31.72	25.92	39.32	38.38	40.22	[illegible]	64.37
POWER	25.98	32.95	31.29	21.59	34.44	37.46	38.80	32.86	72.47
VOLUME	30.91	34.33	30.38	24.17	39.62	39.00	38.11	35.76	66.15
THERMAL	25.82	29.11	28.15	22.29	34.28	33.63	35.66	33.55	72.47
RELIAB-Y	28.08	31.86	29.02	24.02	37.68	37.40	38.22	36.71	70.90
MAINTENC	27.00	30.78	29.13	23.05	37.35	37.21	38.73	36.62	70.64
SAFETY	27.00	30.77	31.87	24.26	35.95	35.55	[illegible]	36.16	70.90
DEV COST	26.70	29.69	27.45	22.75	37.48	34.20	34.96	[illegible]	72.47

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	27.80	31.67	29.87	23.50	37.01	36.59	38.05	35.75	70.05
WEIGHT	24.10	29.02	27.66	20.61	34.25	34.46	35.96	32.88	76.82
POWER	29.97	30.16	28.18	25.77	40.07	35.55	37.15	39.21	67.15
VOLUME	24.29	28.69	29.30	22.74	34.07	33.89	37.98	35.75	74.42
THERMAL	30.16	34.74	31.93	24.94	40.26	40.13	40.90	38.38	67.15
RELIAB-Y	27.50	31.48	30.78	22.95	36.29	35.73	37.87	34.74	69.14
MAINTENC	28.64	32.62	30.66	23.97	36.64	35.94	37.32	34.84	69.42
SAFETY	28.64	32.63	27.75	22.70	38.13	37.70	36.17	35.32	69.14
DEV COST	29.10	34.05	32.76	24.39	36.44	39.44	41.73	35.07	67.15

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE 17
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - GARMENT/LINEN WASHER/DRYER-DISPOSABLE CLOTHES (SPACE STATION)
(09/16/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3	4	5	6	7	8	9
WEIGHT	520.50	1529.0	15	9.89	8.86	7.90	8.00	9.83	8.79	9.73	9.83	.00
POWER	.00000	319.57	15	.80	7.10	7.10	.00	.80	7.10	7.10	.00	15.00
VOLUME	46.259	290.00	10	8.39	7.95	3.91	3.56	8.41	7.98	3.92	3.58	.00
THERMAL	.00000	703.04	15	.51	.00	1.29	1.29	.51	.00	1.29	1.29	15.00
RELIAB-Y	.31689-01	1.0000	5	.53	.54	.00	.63	1.36	1.58	.70	1.85	5.00
MAINTENC	.99994	.99999	5	.07	.03	.19	.39	2.45	2.91	3.10	3.30	4.54
SAFETY	.00000	2.0000	5	.00	.00	5.00	2.50	.00	.00	5.00	2.50	5.00
DEV COST	.00000	70.000	15	2.14	1.07	.00	2.14	6.43	1.07	.00	6.43	15.00
REC COST	41.580	1476.0	15	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58	.00
TOTAL PT	.00000	100.00	100	36.85	40.14	39.97	33.11	44.36	44.03	45.42	43.36	59.54
RATING	-.00000	100.00	100	36.85	40.14	39.97	33.11	44.36	44.03	45.42	43.36	59.54

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 $
(BASED ON 100 $ MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	36.85	40.19	39.97	33.11	44.36	44.03	45.42	43.36	59.54
WEIGHT	38.88	41.96	40.86	34.52	45.84	45.05	46.78	44.91	55.39
POWER	34.66	40.69	40.49	30.80	41.64	44.26	45.56	40.34	62.36
VOLUME	39.09	42.01	39.93	33.23	46.25	45.73	45.13	43.00	56.70
THERMAL	34.52	37.39	37.78	31.40	41.51	40.96	42.86	40.94	62.36
RELIAB-Y	36.21	39.42	39.00	32.61	43.94	43.73	44.66	43.21	60.53
MAINTENC	35.95	39.17	39.09	32.49	44.47	44.37	45.83	43.91	60.30
SAFETY	35.95	39.16	41.44	33.52	43.28	42.95	46.76	43.52	60.53
DEV COST	35.28	37.84	37.18	31.79	44.26	41.45	42.26	43.33	62.36
REC COST	41.07	44.12	43.97	37.58	48.05	47.74	49.04	47.12	55.39

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 $
(BASED ON 100 $ MAX POINTS)

	CONCEPT 1	2	3	4	5	6	7	8	9
NORMAL	36.85	40.19	39.97	33.11	44.36	44.03	45.42	43.36	59.54
WEIGHT	34.49	38.60	38.94	31.47	42.65	42.84	43.85	41.57	64.37
POWER	39.41	39.55	39.38	35.79	47.53	43.76	45.27	46.88	56.26
VOLUME	34.38	38.07	40.02	32.98	42.27	42.14	45.75	43.76	62.67
THERMAL	39.56	43.39	42.52	35.09	47.68	47.60	48.41	46.18	56.26
RELIAB-Y	37.53	40.89	41.00	33.63	44.80	44.34	46.23	43.52	58.50
MAINTENC	37.80	41.15	40.90	33.75	44.25	43.67	45.00	42.78	58.74
SAFETY	37.80	41.17	38.43	32.67	45.50	45.16	44.03	43.19	58.50
DEV COST	38.68	42.81	43.21	34.63	44.49	47.02	49.11	43.40	56.26
REC COST	31.96	35.51	35.33	27.91	40.08	39.71	41.22	39.00	64.37

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 3.3.3-GARMENT/LINEN/WASHING/DRYING COMBINATIONS

APPLIANCE TYPE \ COMPONENT TYPE NO.	MOTOR ①	PUMP ②	SOLENOID VALVE ③	ACCUMULATOR ④	WATER SEPARATOR ⑥	FILTER ⑨	ELECTRIC SWITCH ⑩	CONTROLLER ⑬	FLUIDIC SWITCH ⑧	HEAT EXCHANGER ⑯	HEATER DC ⑰	BLOWER AIR ⑱	TRANSMISSION ⑦	THERMAL STORAGE UNIT ⑳	DESICCANT CANISTER ㉑	○	NUMBER OF SAFETY CRITICAL ITEMS
FLUIDIC AGITATION/FORCED HOT AIR-ELECTRIC HEATER	6	2	2	2	1	1	7	1	10	1	1	1	1	-	-		2
FLUIDIC AGITATION/FORCED HOT AIR-THERMAL HEATER	6	2	2	2	1	1	7	1	10	-	-	1	1	1	-		2
FLUIDIC AGITATION/FORCED AIR DRYING RACK	5	2	2	2	1	1	7	-	10	1	-	1	-	-	-		0
FLUIDIC AGITATION/ELECTRICALLY HEATED DRYING RACK	5	2	2	2	1	1	7	-	10	1	1	1	-	-	-		1
WATER SPRAY AGITATION/FORCED HOT AIR-ELECTRIC HEATER	3	1	2	2	1	1	4	1	-	1	1	1	1	-	-		2
WATER SPRAY AGITATION/FORCED HOT AIR-THERMAL STORAGE HEATER	3	1	2	2	1	1	4	1	-	1	1	1	1	-	-		2
WATER SPRAY AGITATION/FORCED AIR DRYING RACK	2	1	2	2	1	1	4	-	-	1	-	1	-	-	-		0
WATER SPRAY AGITATION/ELECTRICALLY HEATED DRYING RACK	2	1	2	2	1	1	4	-	-	1	1	1	-	-	-		1

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

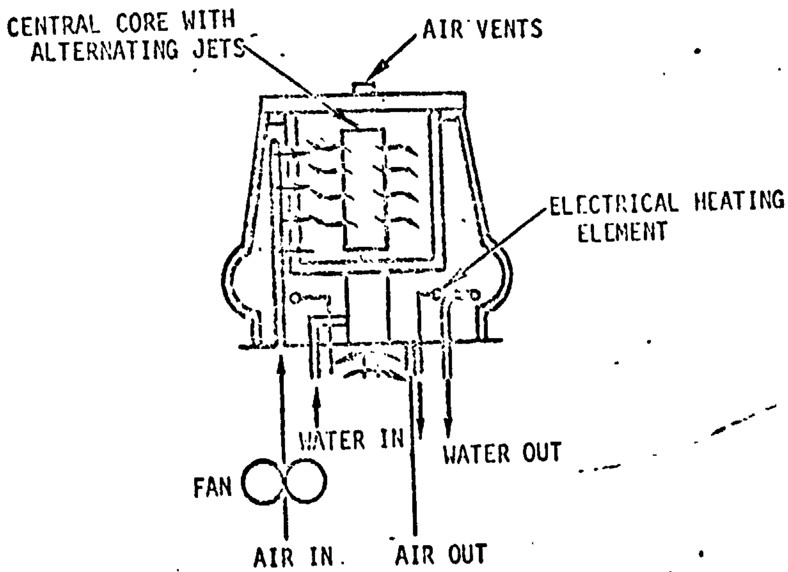
APPLIANCE FUNCTION Garment/Linen Washer/Dryer-Disposable Clothes

APPLIANCE CONCEPT NO./TITLE 1/Fluidic Agitation/Forced Hot Air-Electric Heat

INDEX NO. 3.3.3.1 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 2 and clothes dryer Concept 1, as described previously in Section 3.3.1 and 3.3.2.



5/5

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT FLUIDIC AGITATION/FORCED HOT AIR/ELECTRIC HEAT (REF #70P-2.25 51-59) INDEX NUMBER 3.3.3.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVING		0	55	0				
PUMP		1	32	32	32			
AGITATOR MOTOR		5	150					
FAN		4	10	10	40			
HEATER		4	—	—	—	227	227	908
			237 MAXIMUM		TOTAL	227 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	0	4400	4400	0
PUMP	0	108	108	0
AGITATOR MOTOR	0	512	512	0
FAN	0	34	34	0
HEATER/WATER	265	527	117	675
TOTAL	77.6 (265) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	[illegible] (675) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

5/5

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] AGITATION/[illegible] HOT AIR ELECTRIC HEAT INDEX NUMBER [illegible]

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT •(REF)	WEIGHT (LBS)	VOLUME (FT³)
BASIC WASHER	79	10
PUMP	4	–
2 ACCUMULATORS	40 113	3.6
VALVING	6	18.4
WATER SEPARATOR	3	
PACKAGING	61	
MISCELLANEOUS (WASHER)	–	4.8
BASIC DRYER	40	17.6
MISCELLANEOUS (DRYER)	40	–
CLOTHES	135	25.6
TOTAL	167 (368) KG (LBS)	1.25 (44.0) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
DETERGENT/ GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT³)

TOTAL WT./MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL/MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT³) = 0.020 (0.7) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.0000		0

Σ① ___ Σ④ .0495

TOTAL WT./MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) ÷ 110 (Σ①) = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

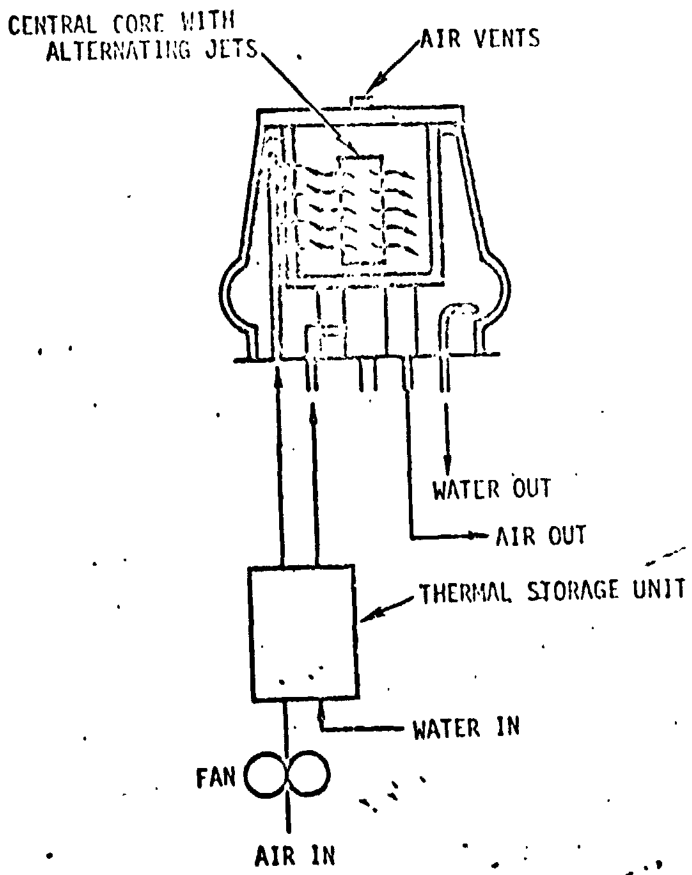
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

APPLIANCE CONCEPT NO./TITLE 2/Fluidic Agitation/Forced Hot Air-Thermal Storage

INDEX NO. 3.3.3.2 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 2 and clothes dryer Concept 2 as described previously in Section 3.3.1 and 3.3.2.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *FLUIDIC AGITATION/FORCED HOT AIR - THERMAL STORAGE* INDEX NUMBER *3.3.3.2*

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVING (WASHER)	*0*	*55*	*0*				
PUMP	*1*	*32*	*32*	*32*			
AGITATOR MOTOR	*5*	*150*					
FAN	*4*	*31*					
		237 MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS (40°F)	*0*	*4400*	*4400*	*0*
PUMP	*0*	*108*	*108*	*0*
MOTOR	*0*	*512*	*512*	*0*
FAN	*0*	*105*	*105*	*0*
WATER/THERMAL STORAGE	*265*	*1053*	*198*	*1120*
TOTAL	*[illegible] (265)* WATT (BTU/HR)	*1471 (5020)* WATT (BTU/HR)	*1471 (5020)* WATT (BTU/HR)	*32? (1120)* WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT FLUIDIC AGITATION/FORCED HOT AIR - THERMAL STORAGE INDEX NUMBER 3.3.3.2
(REF #90, p. 24, 25, 55-57)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)		VOLUME (FT^3)	
BASIC WASHER	79		10	
PUMP	4			
2 ACCUMULATORS	40	19	3.6	
VALVING	6			
WATER SEPARATOR	3			8.4
PACKAGING	61			
MISCELLANEOUS (WASHER)	—		4.8	
DRYER	55			
THERMAL STORAGE UNIT	105		22.7	
MISCELLANEOUS (DRYER)	40	2[illegible]		
CLOTHES	135		25.6	
TOTAL	215 (47[illegible]) KG (LBS)		1.61 (56.7) M^3 (FT^3)	

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DETERGENT/ GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB)

Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = [illegible] (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.0000		0

Σ①

Σ④

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE α ④ = 18.2 (LB) + 110 α ① = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

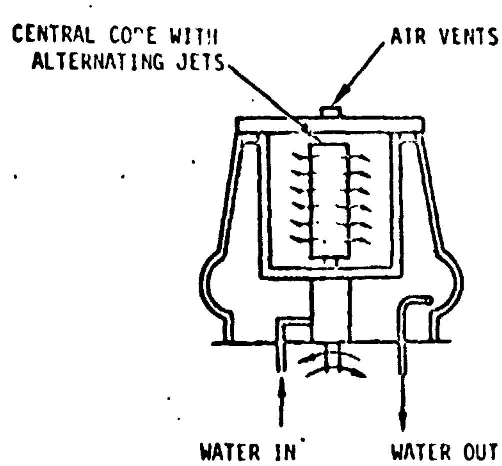
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

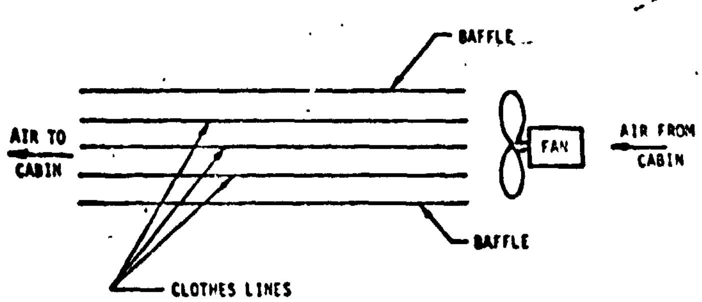
APPLIANCE CONCEPT NO./TITLE 3/Fluidic Agitation/Clothesline-Forced Convection

INDEX NO. 3.3.3.3 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 2 and clothes dryer Concept 8 as described previously in Section 3.3.1 and 3.3.2.





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APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Fluidic Agitation/Clothes Line - Forced Convection (Ref # 90 p. 24, 25, 72, 73) INDEX NUMBER 3.3.3.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valving (washer)	0.	55	0				
Pump	1	32	32	32			
Agitator Motor	1	150	150	150			
Fan	8	7					
		237 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water Heat Loss (40°F)	0	4400	4900	
Pump	0	108	108	
Agitator	0	512	512	
Fan	0	24	24	
Water	133	—	133	
TOTAL	39.0 (133) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT FLUIDIC AGITATION / CLOTHES WASHER - FORCED CONVECTION INDEX NUMBER 2.3.7.3
(REF #90, P 24, 25, 72, 73)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
ELEC WASHER	79	10
PUMP	4	
2 ACCUMULATORS	40	3.6
VALVING	6	18.
WATER SEPARATOR	3	
PACKAGING	61 S/T (193)	
MISC (WASHER)	—	4.8
DRYER	25	150
FAN	25 S/T (243)	
CLOTHES	135	25.6
TOTAL	259 (571) KG (LBS)	4.92 (173.9) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DETERGENT/ GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT. WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT. VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.0000		

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE ∝ ④ = 18.2 (LB) + 110 ∝ ① = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

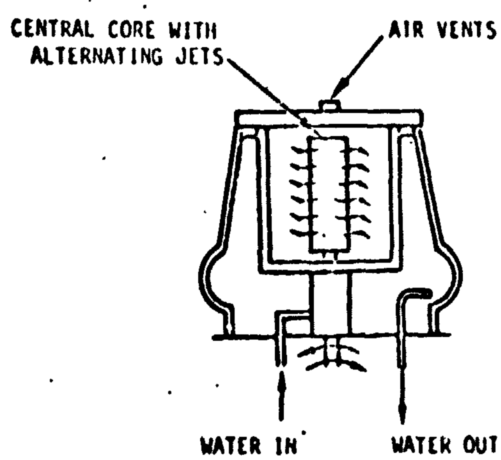
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

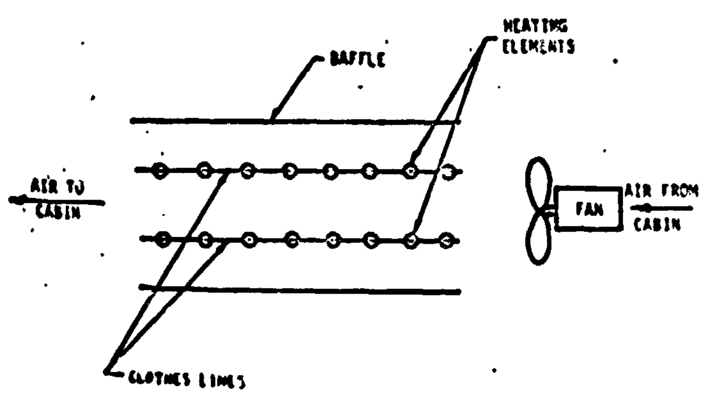
APPLIANCE CONCEPT NO./TITLE 4/Fluidic Agitation/Clothesline-Forced Convection with Electric Heat

INDEX NO. 3.3.3.4 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 2 and clothes dryer Concept 9 as described previously in Section 3.3.1 and 3.3.2.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT FLUIDIC AGITATION/CLOTHES LINE - FORCED CONVECTION WITH ELECTRIC HEAT (Ref. #90, P24 & 14.75) INDEX NUMBER 7.3.4.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVING	0	55	0				
PUMP	1	32	.32	.32			
AGITATOR MOTOR	1	150	150	150			
FAN	4	3					
HEATER	4				256		
		237 MAXIMUM		TOTAL	256 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS (30°F)	0	4400	4400	0
PUMP	0	108	108	0
AGITATOR MOTOR	0	512	512	0
FAN	0	10	10	0
HEATER/WATER	265	608	873	0
TOTAL	77.6 (265) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	0 (0) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT FLUIDIC AGITATION/CLOTHES LINE – FORCED CONVECTION PLUS ELECTRIC HEAT INDEX NUMBER 3.3.3.4

(REF #90, F24,25,77,75)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)		VOLUME (FT³)
BASIC WASHER	79		10
HEAT	4		
2 ACCUMULATORS	40	193	3.6
VALVING	6		
WATER SEPARATOR	2		
PACKAGING	61		
MISC	—		4.8
DRYER	25		1.10
FAN	5		
CLOTHES	135		25.6
TOTAL	254 (561) KG (LBS)		5.21 (184) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
DETERGENT/GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT³) = [illegible] (0.7) M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.000		0

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ ④) + 18.2 (LB) + 110 (Σ ①) = [illegible] (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

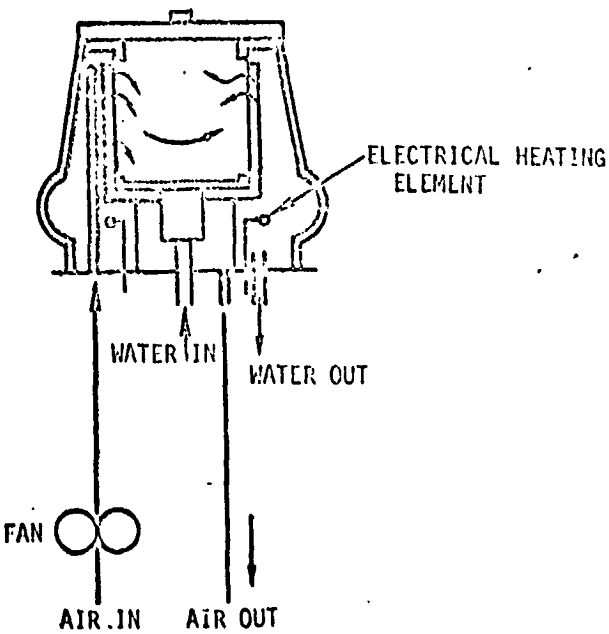
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

APPLIANCE CONCEPT NO./TITLE 5/Water Spray Agitation/Force Hot Air-Electric Heat

INDEX NO. 3.3.3.5 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 7 and clothes dryer Concept 1, as described previously in Section 3.3.1 and 3.3.2.



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APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT *WATER SPRAY AGITATION / FORCED HOT AIR ELECTRIC HEAT* INDEX NUMBER *3.3.3.5*

(REF #90-P 36, 37, 51-54)

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVES		*0*	*55*					
PUMP		*1*	*32*					
AGITATOR MOTOR		*5*	*150*					
FAN		*4*	*10*					
HEATER		*4*	*—*			*227*		
			237 MAXIMUM		TOTAL	*227* MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS (40°F)	*0*	*4400*	*4400*	*0*
PUMP	*0*	*108*	*108*	*0*
MOTOR	*0*	*512*	*512*	*0*
FAN	*0*	*34*	*34*	*0*
HEATER/WATER	*265*	*527*	*117*	*675*
TOTAL	*77.[illegible] (265)* WATT (BTU/HR)	*1471 (5020)* WATT (BTU/HR)	*1471 (5020)* WATT (BTU/HR)	*19[illegible] ([illegible])* WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] AGITATION/FORCED HOT AIR ELECTRIC HEAT INDEX NUMBER 3.2.3.5
(REF #90 - P 56,37, 51-54)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)		VOLUME (FT^3)	
BASIC WASHER	80		10.5	
PUMP	4			
2 ACCUMULATORS	40		3.6	
VALVING	6	200		17.1
WATER SEPARATOR	3			
PACKAGING	67			
MISC (WASHER)	—		3.8	
DRYER	40		17.6	
MISC (DRYER)	40	175	—	
CLOTHES	125		25.6	
TOTAL	170 (375) KG (LBS)		1.23 (43.5) M^3 (FT^3)	

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DETERGENT/ GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB)   Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.0000		0

Σ① 110   Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ ④) = 18.2 (LB) + 110 (Σ ①) = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

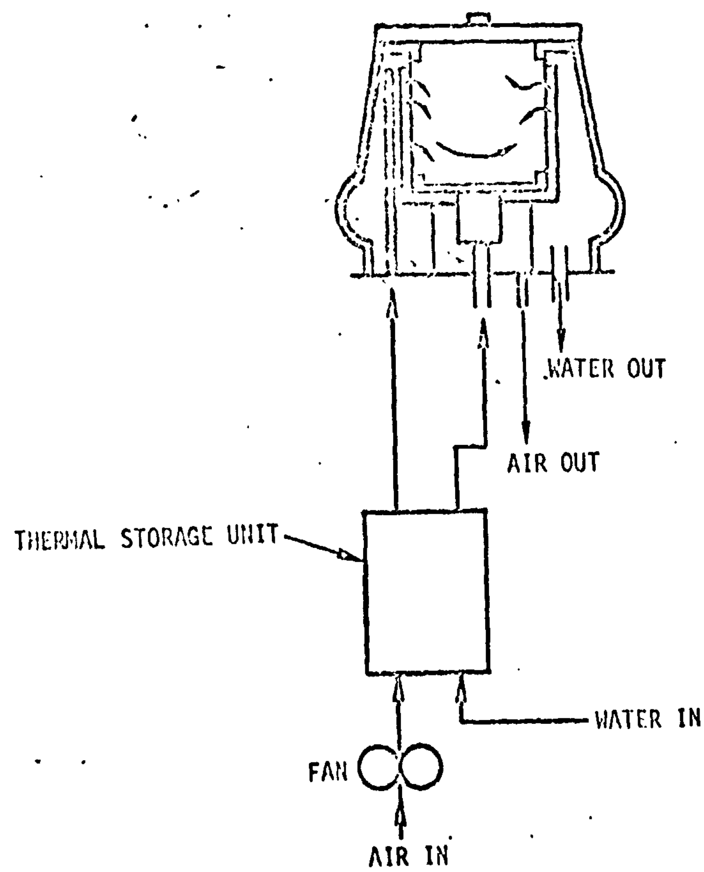
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

APPLIANCE CONCEPT NO./TITLE 6/Water Spray Agitation/Forced Hot Air-Thermal Storage

INDEX NO. 3.3.3.6 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 7 and clothes dryer Concept 2 as described previously in Section 3.3.1 and 3.3.2.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT WATER SPRAY AGITATION / FORCED HOT AIR • THERMAL STORAGE (REF #90, P36, 37, 55-57) INDEX NUMBER 3.3.3.6

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
VALVES	0.	55					
PUMP	1	32					
AGITATOR MOTOR	5	150					
FAN	4	31					
		237 MAXIMUM		TOTAL	0 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS (90°F)	0	4400	4400	0
PUMP	0	108	108	0
MOTOR (AGITATOR)	0	512	512	0
FAN	0	105	105	0
WATER / THERMAL STORAGE	265	1053	198	1120
TOTAL	77.6 (265) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	328 (1120) WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Water Spray Agitation/Force Hot Air-Thermal Storage INDEX NUMBER 3.3.3.6

(ALF #90, P 637 55-57)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Basic washer	80	10.5
Pump	4	
2 Accumulators	40	3.6
Valving	6	
Water separator	3	
Packaging	67	
Misc (washer)	—	3.8
Thermal storage unit	105	
Misc (dryer)	40	22.1
Dryer	35	
Clothes	135	25.6
TOTAL	218 (480) KG (LBS)	1.58 (55.7) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
Detergent/Germicide	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB)

Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT.WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT.VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
Wash water	55	.9991		.0495
Rinse water	55	1.0000		0

Σ① 110

Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE (Σ④) = 18.2 (LB) + 110 (Σ①) = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

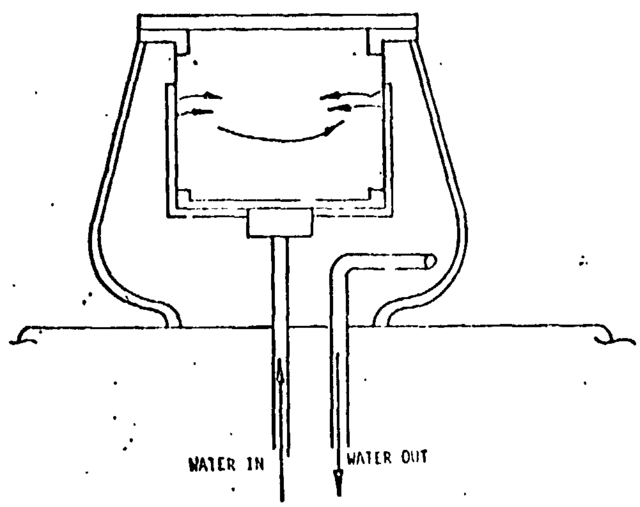
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

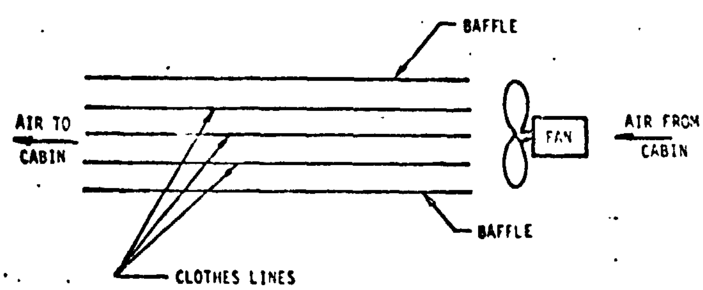
APPLIANCE CONCEPT NO./TITLE 7/Water Spray Agitation/Clothesline-Forced Convection

INDEX NO. 3.3.3.7 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 7 and clothes dryer Concept 8 as described previously in Section 3.3.1 and 3.3.2.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT Water Flag Agitation/Clothes Line - Forced Convection INDEX NUMBER 3.3.3.7
(REF #90 P 26, 27, 72, 73)

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
Valves	0.	55					
Pump	1	22					
Agitator Motor	1	150					
Fan	8	7					
		237. MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Water Heat Loss (-2°F)	0	4400	4400	
Pump	0	108	108	
Motor (Agitator)	0	512	512	
Fan	0	24	24	
Water	133	—	133	
TOTAL	39.0 (133) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT WATER SPRAY AGITATION/CLOTHES LINE-FORCED CONVECTION INDEX NUMBER 3.3.3.7
(REF H40, F26, 31, 72, 73)

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)		VOLUME (FT^3)
BASIC WASHER	80	200	10.5
PUMP	4		
2 ACCUMULATORS	40		2.6
VALVING	6		
WATER SEPARATOR	3		
PACKAGING	67		
MISC (WASHER)	—		3.8
FAN	25		
DRYER	25		130
CLOTHES	135		25.6
TOTAL	175 (385) KG (LBS)		4.91 (172) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DETERGENT/ GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB) Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT. WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOTAL VOL MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT. VOL/CYCLE (FT^3) = 0.020 (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	55	.9991		.0495
RINSE WATER	55	1.0000		0

Σ① 110 Σ④ .0495

TOTAL WT. MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0495 TOTAL LOST/CYCLE α ④ = 18.2 (LB) + 110 α ① = 58.2 (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/Linen Maintenance

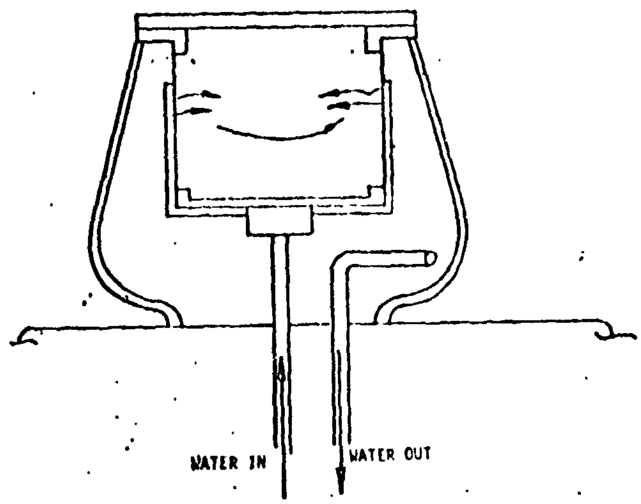
APPLIANCE FUNCTION Garment/Linen-Washer/Dryer-Disposable Clothes

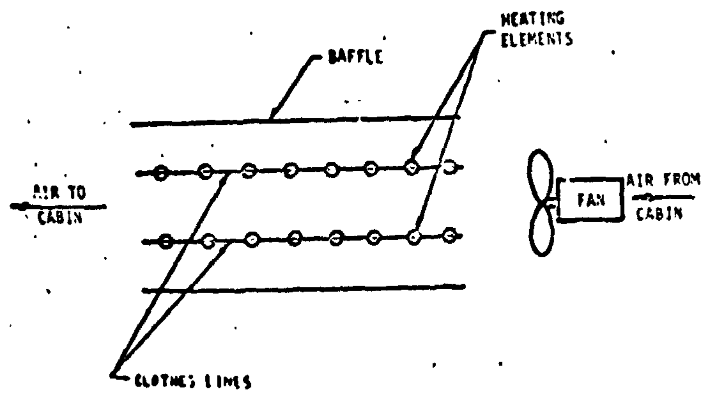
APPLIANCE CONCEPT NO./TITLE 8/Water Spray Agitation/Clothesline-Forced Convection with Electric Heat

INDEX NO. 3.3.3.8 REF. NO. 90

DESCRIPTION

This concept is a combination of clothes washer Concept 7 and clothes dryer Concept 9 as described previously in Section 3.3.1 and 3.3.2.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT: WATER SPRAY AGITATION / CLOTHES LINE - FORCED CONVECTION WITH ELECTRIC HEAT INDEX NUMBER 2.3.3.8

(REF #90, P 35,57,74,75)

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
VALVES		0	55					
PUMP		1	32.					
AGITATOR MOTOR		1	150	150	150			
FAN		4	3					
HEATER		4				256		
			237. MAXIMUM		TOTAL	256 MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS (70°F)	0	4400	4400	
PUMP	0	108	108	
MOTOR (AGITATOR)	0	512	512	
FAN	0	10	10	
HEATER/WATER	265	608	873	
TOTAL	77.6 (265) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	1471 (5020) WATT (BTU/HR)	0 WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT [illegible] / CLOTHES LINE - FORCED CONVECTION [illegible] ELECTRIC HEAT (REF [illegible], 74, 75) INDEX NUMBER 3.3.3.B

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
[illegible]	80	10.5
[illegible]	1	
[illegible]	40	3.5
[illegible]	6	
[illegible]	3	
[illegible]	67	
[illegible]	—	3.8
DRYER	35	140
FAN	5	
CLOTHES	125	29.6
TOTAL	170 (375) KG (LBS)	5.19 ([illegible]) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
DETERGENT / GERMICIDE	1	.055 (.066)	.066	.0016 (.0019)	.0019

Σ③ .066 TOTAL WT/CYCLE (LB)   Σ⑤ .0019 TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .066 TOT. WT/CYCLE (LB) = 11.0 (24.3) KG (LB)

TOT. VOL/MISSION = 2 CYCLES/DAY x 184 DAYS/MISSION x .0019 TOT. VOL/CYCLE (FT^3) = 0.[illegible] (0.7) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
WASH WATER	.55	.7791		.0415
RINSE WATER	.55	1.0000		0

Σ① ______   Σ④ ______

TOTAL WT./MISSION = 2 CYCLE/DAY x 184 DAYS/MISSION x .0415 TOTAL LOST/CYCLE ≈ ③ = 18.2 (LB) + 110 ≈ ① = 55.[illegible] (128.2) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Housekeeping HABITABILITY FUNCTION Garment/ Linen Maintenance

APPLIANCE FUNCTION Garment/Linen Washer/Dryer - Disposable Clothes

APPLIANCE CONCEPT NO./TITLE 9/Disposable Clothes

INDEX NO. 3.3.3.9 REF. NO.

DESCRIPTION : This concept assumes no clothes washer/dryer will be used, and soiled clothing will simply be disposed of and replaced by new ones. An average wear rate of .484 kg (1.066 lb) clothing/towels/washcloths per man per day was assumed from Reference 245. A packaging weight factor of 1.3 was used from Reference 100. Bulk density of the clothes, including packaging, was assumed to be 0.0119 cu m/kg (0.190 cu ft/lb) as recommended in Reference 100.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT [illegible] INDEX NUMBER [illegible]

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)x(7)
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Disposable Clothes INDEX NUMBER 22.3.9

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
Clothes	1529	290
TOTAL	694 (1529) KG (LBS)	8.21 (290) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①X② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①X④ (FT^3)
N/A					
		Σ③	TOTAL WT/CYCLE (LB)	Σ⑤	TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ______ CYCLES/DAY X ______ DAYS/MISSION X ______ TOT.WT/CYCLE (LB) = ______ KG (LB)

TOTAL VOL MISSION = ______ CYCLES/DAY X ______ DAYS/MISSION X ______ TOT.VOL/CYCLE (FT^3) = ______ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①X② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				
Σ①			Σ④	

TOTAL WT. MISSION = ______ CYCLE/DAY X ______ DAYS/MISSION X ______ TOTAL LOST/CYCLE (Σ④) = ______ (LB) + ______ (Σ①) = ______ KG (LB)

HABITABILITY SUBSYSTEM Off-Duty Activity

APPLIANCE FUNCTIONS CONSIDERED

4.1.1 Music
4.1.2 Library
4.1.3 Television
4.1.4 Games
4.2.1 Exercisers

DESCRIPTION

The off-duty activity habitability subsystem was designed to provide the crew entertainment and physical exercise in their off-duty hours. The subsystem considered by the study is primarily based on the off-duty equipment provided for Skylab and Apollo crews. A television receiver was the only addition to the subsystem. The Shuttle Orbiter would not utilize most of the equipment presented in this subsystem due to the present mission duration. The equipment was, however, considered for Shuttle Orbiter for the benefit of future missions as they are extended with the addition of payloads such as Spacelab.

HABITABILITY SUBSYSTEM 4.0 Off-Duty Activity

HABITABILITY FUNCTION 4.1 Entertainment

APPLIANCE FUNCTION 4.1.1 Music

NUMBER OF CONCEPTS CONSIDERED 1

ASSUMPTIONS

(1) The music appliance function provides the crewmen with music and a means of recording. A system to play the recorder through speakers mounted in the spacecraft is provided for better fidelity of sound.

(2) The actual Skylab equipment was used for the appliance function. This was the only concept used because of the simplicity of the appliance function.

(3) The Skylab equipment quantities were ratioed by crew size; i.e., six men divided by three men for Space Station and four men divided by three men for Shuttle. The weight and volumes were then multiplied by these ratios.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 9.1.1 **** MUSIC (SPACE STATION)

CONCEPT NO. (--)	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	3.000 2.000						0. (0.)	30. (102.)	30.0 .0	30.0 .0	66.9 (146.4)	.08 (2.98)	1	5	.0 (.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1	CASSETTE PLAYER/RECORDER

ORIGINAL PAGE IS OF POOR QUALITY

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 4.0-OFF-DUTY ACTIVITIES

COMPONENT TYPE / APPLIANCE TYPE	NUMBER OF COMPONENTS																NUMBER OF SAFETY CRITICAL ITEMS
NO.																	

NO MECHANICAL/ELECTRICAL COMPONENTS RECORDED FOR THE 4.0 APPLIANCE FUNCTIONS, SINCE NO TRADES WERE MADE FOR THE APPLIANCE FUNCTIONS.

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

APPLIANCE FUNCTION Music

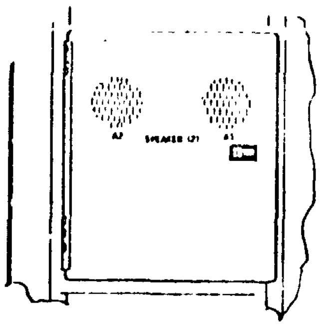
APPLIANCE CONCEPT NO./TITLE 1/Cassette Player/Recorder

INDEX NO. 4.1.1.1 REF. NO. 293, 96

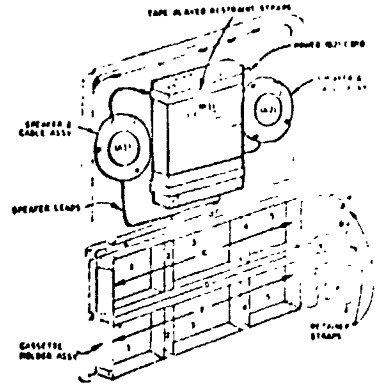
DESCRIPTION

The cassette player/recorder concept includes the following equipment: (1) tape player/recorder, (2) headsets, (3) microphone kit, (4) power cord/converter, (5) batteries, (6) cassette kit, and (7) wardroom speakers. The tape player can be used on conventional batteries or via a converter from 28 VDC to 6 VDC on spacecraft power. The tape recorder plays cassettes and is provided with a speaker and an adaption to headsets for private use. The number of units provided for each of the above units is summarized below:

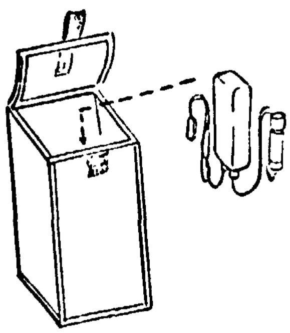
	Shuttle	Space Station
Tape recorder	5	7
Headsets	3	4
Microphones	3	4
Power cord/converter	1	2
Batteries	adequate for mission duration	
Cassettes	80	120
Speaker	1	1



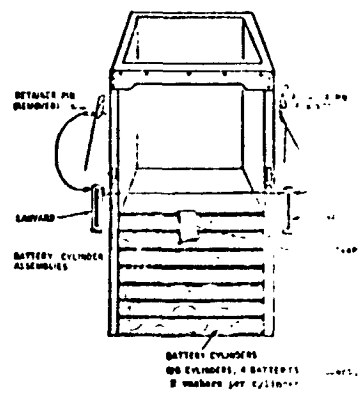
SPEAKER DOOR (FRONT VIEW)



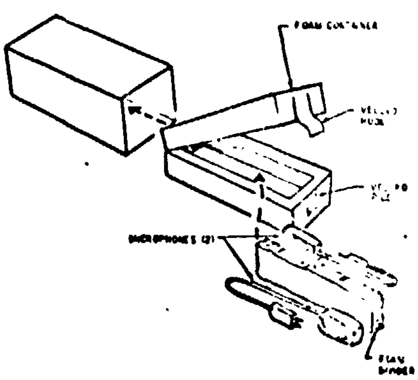
SPEAKER DOOR (REAR VIEW)



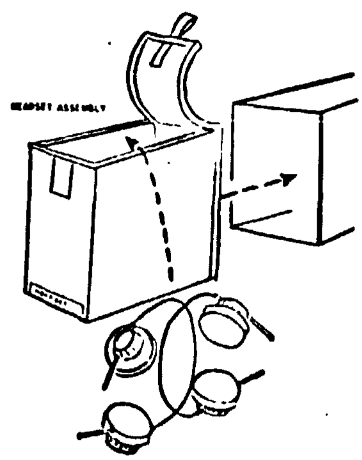
POWER CORD/CONVERTER



BATTERY DISPENSER



MICROPHONE



HEADSETS

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATION

CONCEPT *CASSETTE PLAYER/RECORDER* INDEX NUMBER *4.1.1.1*

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(7)
CASSETTE PLAYER MOTOR	*2*	*30*	*30*	*60*			
		30 MAXIMUM		*60* TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
CASSETTE MOTOR	*—*	*102.3*	*102.3*	*—*
TOTAL	*—* WATT (BTU/HR)	*30 (102.3)* WATT (BTU/HR)	*30 (102.3)* WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLICABLE CONCEPTS, EXPENDABLES, WEIGHTS/VOLUMES CALCULATIONS (CONTINUED)

CONCEPT 1/CASSETTE PLAYER/RECORDER PROCEDURE 4.1.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
TAPE PLAYER	46.5	.707
HEADSETS	6.16	.397
MICROPHONES	3.73	.146
BATTERIES	50.00	.75
CASSETTES	17.5	.406
WARDROOM SPEAKERS	15.85	.903
POWER CORD/CONVERTER	6.63	.174
TOTAL	66.39 (146.4) KG (LBS)	.084 (2.98) M³ (FT³)

RESUPPLY SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/~~CYCLE~~ MISSION ①×② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/~~CYCLE~~ MISSION ①×④ (FT³)
BATTERIES	—	—	41.0		.60
CASSETTES	—	—	8.7		.30

Σ③ 49.7 TOTAL WT/~~CYCLE~~ MISSION (LB)   Σ⑤ .90 TOTAL VOL/~~CYCLE~~ MISSION (FT³)

TOTAL WT. MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.WT/CYCLE (LB) = [22.54 (49.7)] KG (LB)

TOTAL VOL MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.VOL/CYCLE (FT³) = [.025 (.90)] M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①×② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ____   Σ④ ____

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x ____ TOTAL LOST/CYCLE (Σ④) + ____ (LB) (Σ①) = [____] KG (LB)

HABITABILITY SUBSYSTEM 4.0 Off-Duty Activity

HABITABILITY FUNCTION 4.1 Entertainment

APPLIANCE FUNCTION 4.1.2 Library

NUMBER OF CONCEPTS CONSIDERED 1

ASSUMPTIONS

(1) The library appliance function provides the crewmen with reading material for off-duty time. Provisions are added to make the paper books non-flammable by adding covers while the books are in use.

(2) The actual Skylab equipment was used for the library appliance function. This was the only concept used because of the short mission duration.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 4.1.2 **** LIBRARY (SPACE STATION)

CONCEPT NO.	USAGE TIME	CONSUMABLES AND FLOW REQUIREMENTS					THERMAL REQMTS		ELEC PWR R QMTS		WT/VOL REQMTS		DEVELOPMENT COST		RESUPPLY
	USES/DAY HRS/USE	TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	AVAIL (**)	INDEX (***)	WEIGHT -KG- (LBS)
1	3.000 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	6.3 (13.8)	.01 (.50)	1	5	.0 (.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	BOOKS

ORIGINAL PAGE IS OF POOR QUALITY

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

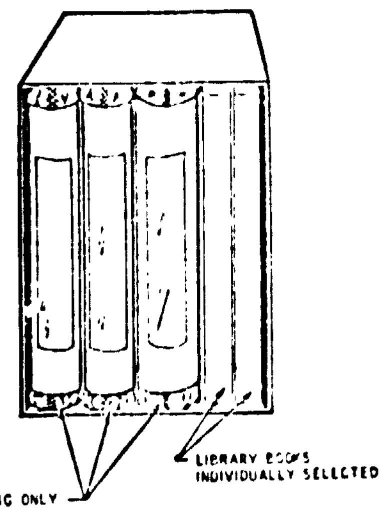
APPLIANCE FUNCTION Library

APPLIANCE CONCEPT NO./TITLE 1/Books

INDEX NO. 4.1.2.1 REF. NO. 293, 96

DESCRIPTION

The book concept consists of individually selected off-the-shelf paperback books taken on the mission. The books are stored and when in use are provided with a cover for nonflammability. The covers are fabricated from Beta cloth.



APPLIANCE CONCEPT ELECTRICAL, THERMAL & OPERATIONAL PENALTIES CALCULATIONS

CONCEPT: 1/BOOKS INDEX NO.: 4.1.2.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)×(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)×(6)
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

[illegible] (CONTINUED)

CONCEPT 1/ BOOKS INDEX NUMBER 4.1.2.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
BOOKS		13.8	.495
TOTAL		6.124 (13.8) KG (LBS)	.014 (.495) M^3 (FT^3)

RESUPPLY SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/~~CYCLE~~ MISSION ①×② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/~~CYCLE~~ MISSION ①×④ (FT^3)
BOOKS			10.92		.495

Σ③ 10.92 TOTAL WT/~~CYCLE~~ MISSION (LB) Σ⑤ .495 TOTAL VOL/~~CYCLE~~ MISSION (FT^3)

TOTAL WT. MISSION = ___ CYCLES/DAY x ___ DAYS/MISSION x ___ TOT. WT/CYCLE (LB) = 4.994 (10.9) KG (LB)

TOTAL VOL MISSION = ___ CYCLES/DAY x ___ DAYS/MISSION x ___ TOT. VOL/CYCLE (FT^3) = .014 (.495) M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①×② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ___ Σ④ ___

TOTAL WT. MISSION = ___ CYCLE/DAY x ___ DAYS/MISSION x TOTAL [illegible] CYCLE (Σ④) ___ (LB) + ___ (Σ①) = ___ KG (LB)

HABITABILITY SUBSYSTEM 4.0 Off-Duty Activity

HABITABILITY FUNCTION 4.1 Entertainment

APPLIANCE FUNCTION 4.1.3 Visual Recreation

NUMBER OF CONCEPTS CONSIDERED 1

ASSUMPTIONS

(1) The visual appliance function provides the means for programed television to be displayed on board the spacecraft.

(2) The Panasonic and Sony television sets were the basis for the engineering numbers.

(3) One unit was assumed to be provided for each vehicle.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO 4.1.3 **** VISUAL RECREATION (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	3.000 2.000						0. (0.)	120. (409.)	120.0 .0	.0 .0	22.7 (50.0)	.12 (4.27)	3	75	.0 (.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	TELEVISION

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

APPLIANCE FUNCTION Visual Recreation

APPLIANCE CONCEPT NO./TITLE 1/Television

INDEX NO. 5.1.3.1 REF. NO. 1

DESCRIPTION

The television concept provides programed television programs to the crewmen. The data presented were based on 15-inch Panasonic. The Sony is also very similar to this model. The unit does not provide the means for use of video tape.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 1/TELEVISION INDEX NUMBER 5.1.3.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)X(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)X(6)
TELEVISION	6	120	120	720	—	—	—
		120 MAXIMUM		720 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
HEAT LEAK		409	409	
TOTAL	WATT (BTU/HR)	119.94 (409) WATT (BTU/HR)	119.94 (409) WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT DESCRIPTIONS AND REQUIREMENTS CALCULATIONS (CONTINUED)

CONCEPT 1/TELEVISION   INDEX NUMBER 5.1.3.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
TELEVISION		50	4.27
TOTAL		22.68 (50) KG (LBS)	.121 (4.27) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①×② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①×④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB)   Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = CYCLES/DAY X DAYS/MISSION X TOT WT/CYCLE (LB) = KG (LB)

TOTAL VOL MISSION = CYCLES/DAY X DAYS/MISSION X TOT.VOL/CYCLE (FT^3) = M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①×② (LB)	④ AMT LOST CYCLE ①-③ (LB)
N/A				

Σ①   Σ④

TOTAL WT. MISSION = CYCLE/DAY X DAYS/MISSION X TOTAL LOST/CYCLE (Σ ④) (LB) + (Σ ①) = KG (LB)

HABITABILITY SUBSYSTEM 4.0 Off-Duty Activity

HABITABILITY FUNCTION 4.1 Entertainment

APPLIANCE FUNCTION 4.1.4 Games

NUMBER OF CONCEPTS CONSIDERED 5

ASSUMPTIONS

(1) The games appliance function provides games to occupy crewman time during off-duty activity. The devices used are varied to prevent boredom.

(2) The actual Skylab equipment was used for the appliance function.

(3) The Skylab equipment quantities were ratioed by crew size; i.e., six men divided by three men for Shuttle. The weight and volumes were then multiplied by the ratios.

(4) The concepts presented are not presented for trade purposes. Each of these concepts are candidates for off-duty activity equipment.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 4.1.4 **** GAMES (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (*)	RESUPPLY WEIGHT -KG- (LBS)
1	.500 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	.4 (.8)	.00 (.07)	1	5	.0 (.0)
2	.500 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	.8 (1.8)	.00 (.04)	1	5	.0 (.0)
3	.500 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	5.4 (12.0)	.00 (.17)	1	5	.0 (.0)
4	.500 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	3.0 (6.7)	.00 (.17)	1	5	.0 (.0)
5	.500 2.000						0. (0.)	0. (0.)	.0 .0	.0 .0	3.0 (6.6)	.00 (.13)	1	5	.0 (.0)

APPLIANCE CONCEPT NO. — C O N C E P T N A M E

1 - HANDBALL
2 - DART BOARD/DARTS
3 - BINOCULAR
4 - CARDS
5 - CALCULATOR

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

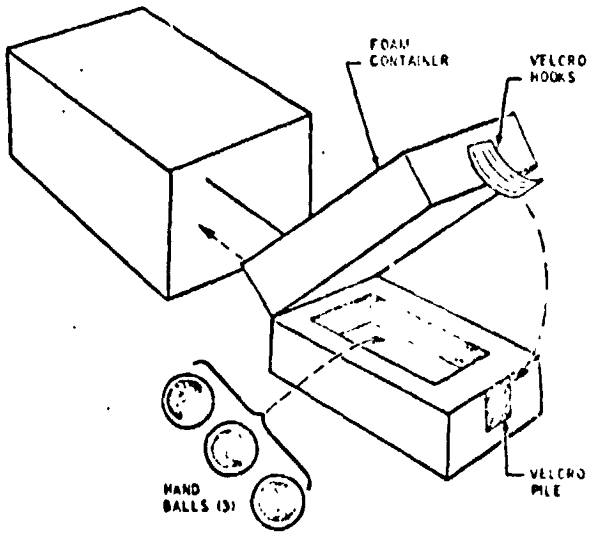
APPLIANCE FUNCTION Games

APPLIANCE CONCEPT NO./TITLE 1/Handball

INDEX NO. 5.1.4.1 REF. NO. 293, 96

DESCRIPTION

The handball concept provides three hand balls, one pyrell, one sponge, and one rubber hand ball. The balls are covered with a nonflammable Fluorel covering. One commercial ball is coated with Fluorel. The pyrell NERF ball was dipped in ammonium-dehydrogen phosphate and coated with Fluorel. The third ball is a toy ball coated with Fluorel. The balls are ckaged in a sponge rubber container.



APPLIANCE CONCEPT EQUIPMENT [illegible] CALCULATIONS

CONCEPT 1/HANDBALL — INDEX NUMBER 5.19.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) [illegible] (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) [illegible] (WATT HR/CYCLE) [illegible]
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPENDIX C CONCEPT IDENTIFICATION AND RESOURCES ESTIMATE (CONTINUED)

CONCEPT *HANDBALL* INDEX NUMBER *5.1.4.1*

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
HANDBALL KIT		*.784*	*.072*
	TOTAL	*.356 (.784)* KG (LBS)	*.002 (.072)* M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①×② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①×④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB) Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT MISSION ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL MISSION ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①×② (LB)	④ AMT. LOST/CYCLE ①-③ (LB)
N/A	\			

Σ① Σ④

TOTAL WT MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x ____ TOTAL LOST/CYCLE (Σ④) + ____ (LB) + ____ (Σ①) = ____ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

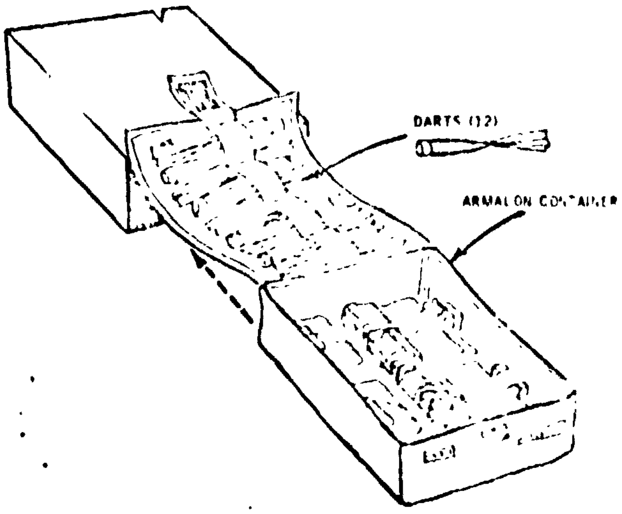
APPLIANCE FUNCTION Games

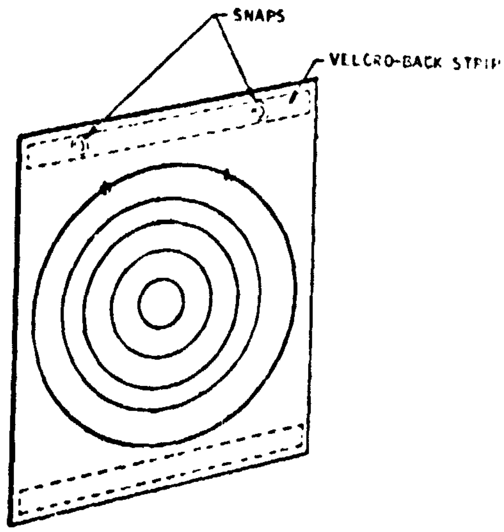
APPLIANCE CONCEPT NO./TITLE 2/Dart Board/Darts

INDEX NO. 4.1.4.2 REF. NO. 293, 96

DESCRIPTION

The dart board concept utilizes darts and board with velcro for a zero-g dart game. Twelve darts were provided with the heads covered with velcro hooks and attach to the board by means of velcro pile/hook attachment system. A dart holder container was provided as part of the concept. The system did not work well on Skylab (darts were not stable), so redesign of this system would be required prior to flight.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/DART BOARD/DARTS

REFERENCE 4.1.4.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE LIFE CYCLE (HR)	A.C. POWER (2) PEAK (WATTS)	(3) AVERAGE (WATTS)	(4) DEMAND (WATT HR/CYCLE) (1)×(3)	D.C. POWER (5) PEAK (WATTS)	(6) AVERAGE (WATTS)	(7) DEMAND (WATT HR/CYCLE) (1)×(6)
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND LEVEL III SPECIFICATIONS (CONTINUED)

CONCEPT 2/DART BOARD/DARTS INDEX NUMBER 4.1.4.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT³)
DARTS		.53	.0374
DART STORAGE		.197	
DART BOARD		1.16	.0012
TOTAL		.833 (1.837) KG (LBS)	.001 (.0386) M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①×② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT³)	⑤ VOL/CYCLE ①×④ (FT³)
N/A					

Σ③ TOTAL WT/CYCLE (LB)   Σ⑤ TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION = CYCLES/DAY x DAYS/MISSION x TOTAL WT/CYCLE (LB) = [ ] KG (LB)

TOTAL VOL MISSION = CYCLES/DAY x DAYS/MISSION x TOTAL VOL/CYCLE (FT³) = [ ] M³ (FT³)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①×② (LB)	④ AMT. LOST/CYCLE ①-③ (LB)
N/A				

Σ①   Σ④

TOTAL WT MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE Σ④ (LB) + Σ① = [ ] KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

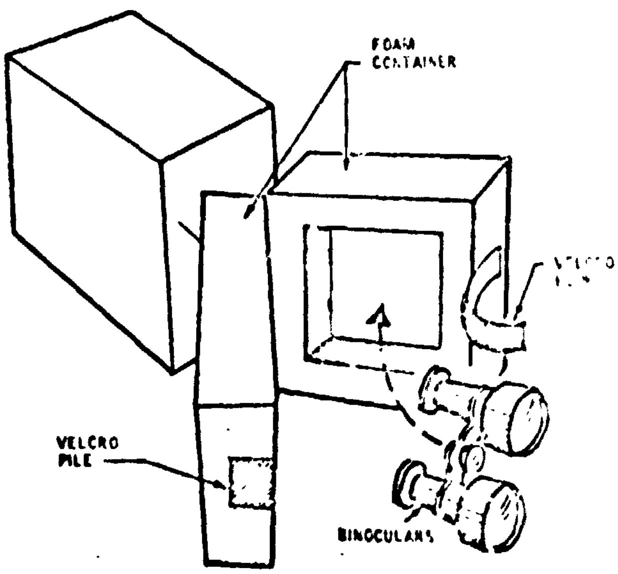
APPLIANCE FUNCTION Games

APPLIANCE CONCEPT NO./TITLE 3/Binocular Kit

INDEX NO. 4.1.4.3 REF. NO. 293, 96

DESCRIPTION

The binocular kit concept provides binoculars for viewing distant objects such as earth and satellites. The binoculars are "trinovid" 10 x 40, manufactured by E. Leitz, Inc. velcro attachment strips are provided for attachment when used in specified areas.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/BINOCULAR KIT INDEX NUMBER 4.1.9.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT-HR/CYCLE) ①x③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT-HR/CYCLE) ①x⑦
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

C-4

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/BINOCULAR KIT | INDEX NUMBER 4.14.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
BINOCULAR KIT	12	.168
TOTAL	5.44 (12) KG (LBS)	.0047 (.168) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①X② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①X④ (FT^3)
N/A					
		Σ③	TOTAL WT/CYCLE (LB)	Σ⑤	TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = ____ CYCLES/DAY X ____ DAYS/MISSION X ____ TOT.WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL/MISSION = ____ CYCLES/DAY X ____ DAYS/MISSION X ____ TOT.VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①X② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				
Σ①			Σ④	

TOTAL WT./MISSION = ____ CYCLE/DAY X ____ DAYS/MISSION X ____ TOTAL LOST/CYCLE (Σ ④) + ____ (LB) + ____ (Σ ①) = ____ KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

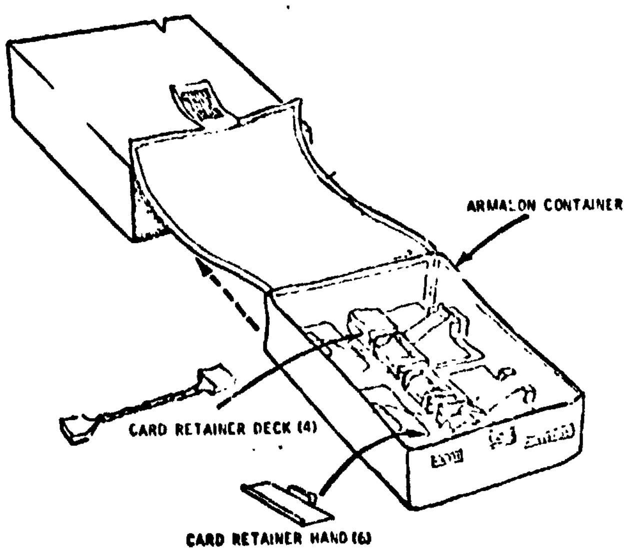
APPLIANCE FUNCTION Games

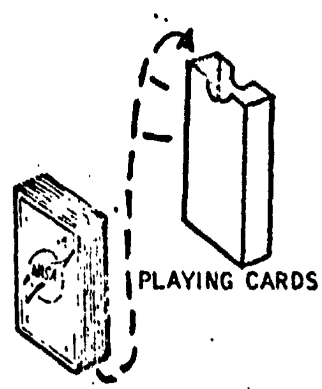
APPLIANCE CONCEPT NO./TITLE 4/Cards

INDEX NO. 4.1.4.4 REF. NO. 293, 96

DESCRIPTION

The cards concept provides card decks and card deck retainers for card playing in zero-g. The card retainer is constructed using a flexible strap with a magnet at each end. The assembly is covered with Beta cloth. The cards are standard cards manufactured using a lamination of three layers of Scheufelin paper E-20. Each deck is stored in an aluminum container for nonflammability. Eight decks of cards were assumed for Space Station and four for Shuttle.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 4/CARDS INDEX NUMBER 4.1.9.4

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT-HR/CYCLE) (1)X(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT-HR/CYCLE) (1)X(7)
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 4/CARDS

INDEX NUMBER 4.1.4.4

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
CARDS/RETAINERS/STORAGE	6.68	.173
TOTAL	3.03 (6.68) KG (LBS)	.0048 (.173) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①X② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①X④ (FT^3)
N/A					

Σ③ ____ TOTAL WT/CYCLE (LB)   Σ⑤ ____ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ____ CYCLES/DAY X ____ DAYS/MISSION X ____ TOT.WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL MISSION = ____ CYCLES/DAY X ____ DAYS/MISSION X ____ TOT.VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①X② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ____   Σ④ ____

TOTAL WT. MISSION = ____ CYCLE/DAY X ____ DAYS/MISSION X TOTAL LOST/CYCLE (Σ④) ____ (LB) + ____ (Σ①) = ____ KG (LB)

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SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Entertainment

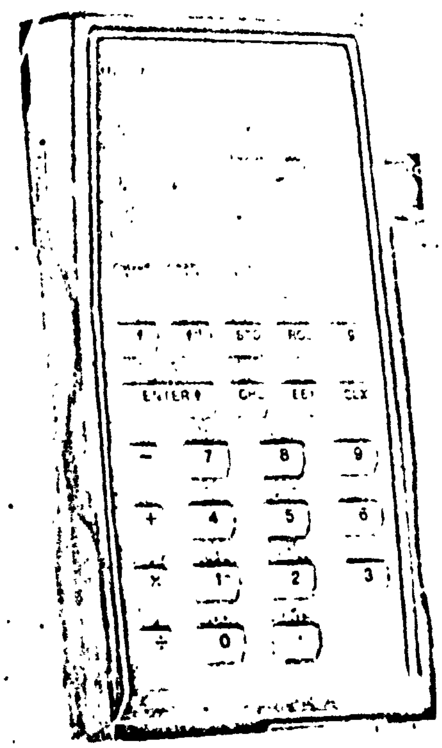
APPLIANCE FUNCTION Games

APPLIANCE CONCEPT NO./TITLE 5/Calculator

INDEX NO. 4.1.4.5 REF. NO.

DESCRIPTION

The calculator concept provides a Hewlett-Packard HP-65 programable pocket calculator. The calculator is an electronic slide rule with programable tapes for special programs. The study assumed four units were supplied for Shuttle and six for Space Station.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 5/CALCULATOR INDEX NUMBER 4.1.4.5

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	A.C. POWER (2) PEAK (WATTS)	(3) AVERAGE (WATTS)	(4) DEMAND (WATT-HR/CYCLE) (1)X(3)	D.C. POWER (5) PEAK (WATTS)	(6) AVERAGE (WATTS)	(7) DEMAND (WATT-HR/CYCLE) (1)X(7)
CALCULATOR	.25	5	5	1.25	—	—	—
		5 MAXIMUM		1.25 TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
CALCULATOR	—	17	17	—
TOTAL	WATT (BTU/HR)	5 (17) WATT (BTU/HR)	5 (17) WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND FACILITIES CALCULATIONS (CONCLUDED)

CONCEPT 5/ CALCULATOR

INDEX NUMBER 9.1.4.5

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
CALCULATOR	4.12	.09
BATTERY PACK	.56	.011
CHARGER	1.87	.028
TAPE UNITS (40)	.063	neg.
TOTAL	2.999 (6.613) KG (LBS)	.0037 (.129) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ① × ② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ① × ④ (FT^3)
N/A					

Σ③ ______ TOTAL WT/CYCLE (LB)   Σ⑤ ______ TOTAL VOL/CYCLE (FT^3)

TOTAL WT./MISSION = ______ CYCLES/DAY X ______ DAYS/MISSION X ______ TOT.WT/CYCLE (LB) = [______] KG (LB)

TOTAL VOL./MISSION = ______ CYCLES/DAY X ______ DAYS/MISSION X ______ TOT.VOL/CYCLE (FT^3) = [______] M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ① x ② (LB)	④ AMT LOST/CYCLE ① - ③ (LB)
N/A				

Σ① ______   Σ④ ______

TOTAL WT./MISSION = ______ CYCLE/DAY X ______ DAYS/MISSION X TOTAL LOST/CYCLE (Σ ④) = ______ (LB) ÷ ______ (Σ ①) = [______] KG (LB)

HABITABILITY SUBSYSTEM 4.0 Off-Duty Activity

HABITABILITY FUNCTION 4.2 Physical Conditioning

APPLIANCE FUNCTION 4.2.1 Exercisers

NUMBER OF CONCEPTS CONSIDERED 2

ASSUMPTIONS

(1) The exercisers appliance function provides for maintenance of crewman physical condition under the influence of zero-gravity.

(2) The actual Skylab equipment was used for the appliance function.

(3) The Skylab equipment quantities were ratioed by crew size; i.e., six men divided by three men for Space Station and four men divided by three men for Shuttle. The weights and volumes were then multiplied by the ratios.

(4) The concepts presented are not presented for trade purposes. Each of these concepts are candidates for off-duty activity equipment.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 4.2.1 **** EXERCISERS (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	6.000 1.009						0. (0.)	0. (0.)	.0 .0	.0 .0	.9 (2.01)	.01 (.36)	1	5	.0 (.0)
2	6.000 .000						0. (0.)	0. (0.)	.0 .0	.0 .0	.2 (.51)	.00 (.09)	1	5	.0 (.0)

APPLIANCE CONCEPT NO.	CONCEPT NAME
1 -	EXER-GYM
2 -	HAND EXERCISER

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SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Physical Conditioning

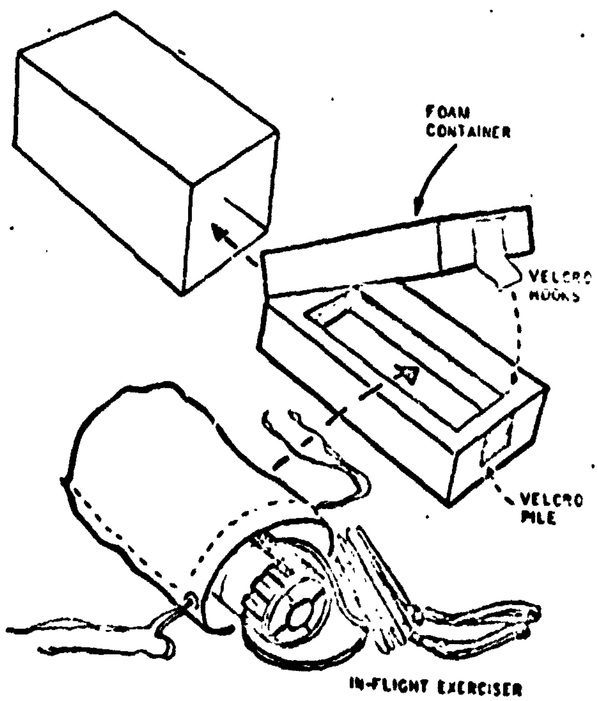
APPLIANCE FUNCTION Exercisers

APPLIANCE CONCEPT NO./TITLE 1/Exer-Gym

INDEX NO. 4.2.1.1 REF. NO. 293, 96

DESCRIPTION

The exer-gym concept is a commercial grade of exer-gyms manufactured by Exer-Genie. The unit provides exercise by means of varying rope tension to produce the desired push/pull restraint forces. Exer-gym works by putting each foot in the strap loops and pulling rope with one or two hands. A storage container is provided for the exer-gym. The study assumed four exer-gyms were provided for Shuttle and six for Space Station.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 1/EXER-GYM

INDEX NUMBER 4.2.1.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(6)
N/A								
			MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONTINUED)

CONCEPT 1/EXER-GYM

INDEX NUMBER 4.2.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
EXER-GYM	1.98	.36
TOTAL	.898 (1.98) KG (LBS)	.010 (.36) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ① x ② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ① x ④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB)   Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = CYCLES/DAY x DAYS/MISSION x TOT. WT/CYCLE (LB) = KG (LB)

TOTAL VOL MISSION = CYCLES/DAY x DAYS/MISSION x TOT. VOL/CYCLE (FT^3) = M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ① x ② (LB)	④ AMT. LOST/CYCLE ① - ③ (LB)
N/A				

Σ①   Σ④

TOTAL WT. MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE (Σ ④) = (LB) = (Σ ①) = KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Off-Duty Activity HABITABILITY FUNCTION Physical Conditioning

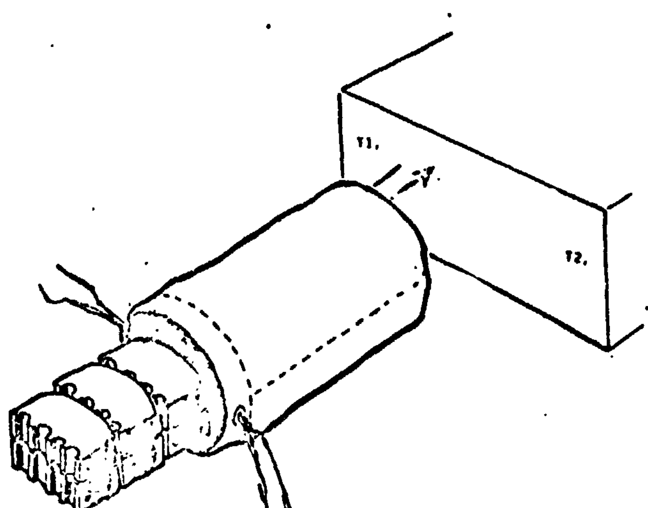
APPLIANCE FUNCTION Exercisers

APPLIANCE CONCEPT NO./TITLE 2/Hand Exerciser

INDEX NO. 4.2.1.2 REF. NO. 293, 96

DESCRIPTION

The hand exerciser concept is provided to keep hand and arm muscle condition. The hand exercisers are shaped to fit the hand and are used as a "squeeze" type exerciser for maintaining grip strength. The units are coated with Fluorel for nonflammability. The study assumed four hand exercisers were provided for Shuttle and six for Space Station.



HAND EXERCISERS

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/HAND EXERCISER INDEX NUMBER 4.2.1.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	① USE TIME CYCLE (HR)	AC POWER ② PEAK (WATTS)	AC POWER ③ AVERAGE (WATTS)	AC POWER ④ DEMAND (WATT HR/CYCLE) ①X③	DC POWER ⑤ PEAK (WATTS)	DC POWER ⑥ AVERAGE (WATTS)	DC POWER ⑦ DEMAND (WATT HR/CYCLE) ①X⑦
N/A							
		MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A				
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONTINUED)

CONCEPT 2/HAND EXERCISER INDEX NUMBER 4.2.1.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
HAND EXERCISERS	.47	.039
TOTAL	.213 (.47) KG (LBS)	.001 (.039) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE(REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB) Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = CYCLES/DAY x DAYS/MISSION x TOT.WT/CYCLE (LB) = KG (LB)

TOTAL VOL MISSION = CYCLES/DAY x DAYS/MISSION x TOT.VOL/CYCLE (FT^3) = M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE(REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① Σ④

TOTAL WT. MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = (LB) + (Σ①) = KG (LB)

HABITABILITY SUBSYSTEM Medical

APPLIANCE FUNCTIONS CONSIDERED

5.1.1 Autoclaves
5.2.1 Ergometers

DESCRIPTION

The medical appliance subsystem considered by the study were those items judged to have a direct interface with the ECLSS. The Space Station will probably include more appliances than were considered in this section; however, the autoclave and ergometer appliances were the only appliance functions defined for a near term Space Station. The Shuttle Orbiter, because of its short-term mission, would not require these appliances. These appliance functions were, however, complied for possible application to future Shuttle missions.

HABITABILITY SUBSYSTEM 5.0 Medical

HABITABILITY FUNCTION 5.1 Sterilization

APPLIANCE FUNCTION 5.1.1 Autoclaves

NUMBER OF CONCEPTS CONSIDERED 3

ASSUMPTIONS

(1) Venting of the autoclave chamber to vacuum was allowed since the contamination level was considered low.

APPLIANCE CONCEPT FUNCTION MATRIX

INDEX NO. 5.1.1 **** AUTOCLAVES (SPACE STATION)

CONCEPT NO.	USAGE TIME USES/DAY HRS/USE	CONSUMABLES AND FLOW REQUIREMENTS TYPE (*)	AMT. USED -KG/USE- (LB/USE)	FLOW * (*)	PRESS -MMHG- (PSIG)	TEMP -DEG C- (DEG F)	THERMAL REQMTS COOLANT -WATTS- (BTU/HR)	HT LEAK -WATTS- (BTU/HR)	ELEC PWR REQMTS PK PWR AC DC -WATTS-	AVG PWR AC DC -WATTS-	WT/VOL REQMTS WEIGHT -KG- (LBS)	VOLUME -CU M- (CU FT)	DEVELOPMENT COST AVAIL (**)	INDEX (***)	RESUPPLY WEIGHT -KG- (LBS)
1	1.000 .500	2	.0603 (.13301)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	308. (1053.)	1520.0 .0	845.0 .0	24.7 (54.4)	.16 (5.58)	1	25	.0 (.0)
		9	.0717 (.15801)	4.54 (10.00)	1551.9 (30.0)	21.1 (70.0)									
2	1.000 2.330						0. (0.)	421. (1438.)	800.0 .0	259.0 .0	10.9 (24.0)	.14 (4.78)	1	25	.0 (.0)
3	1.000 20.100	2	.0603 (.13301)	.00 (.00)	.0 (.0)	.0 (.0)	0. (0.)	112. (381.)	230.0 .0	171.0 .0	239.0 (526.8)	.26 (9.03)	2	45	216.0 (476.2)
		5	.0014 (.00301)	.00 (.00)	.0 (.0)	.0 (.0)									

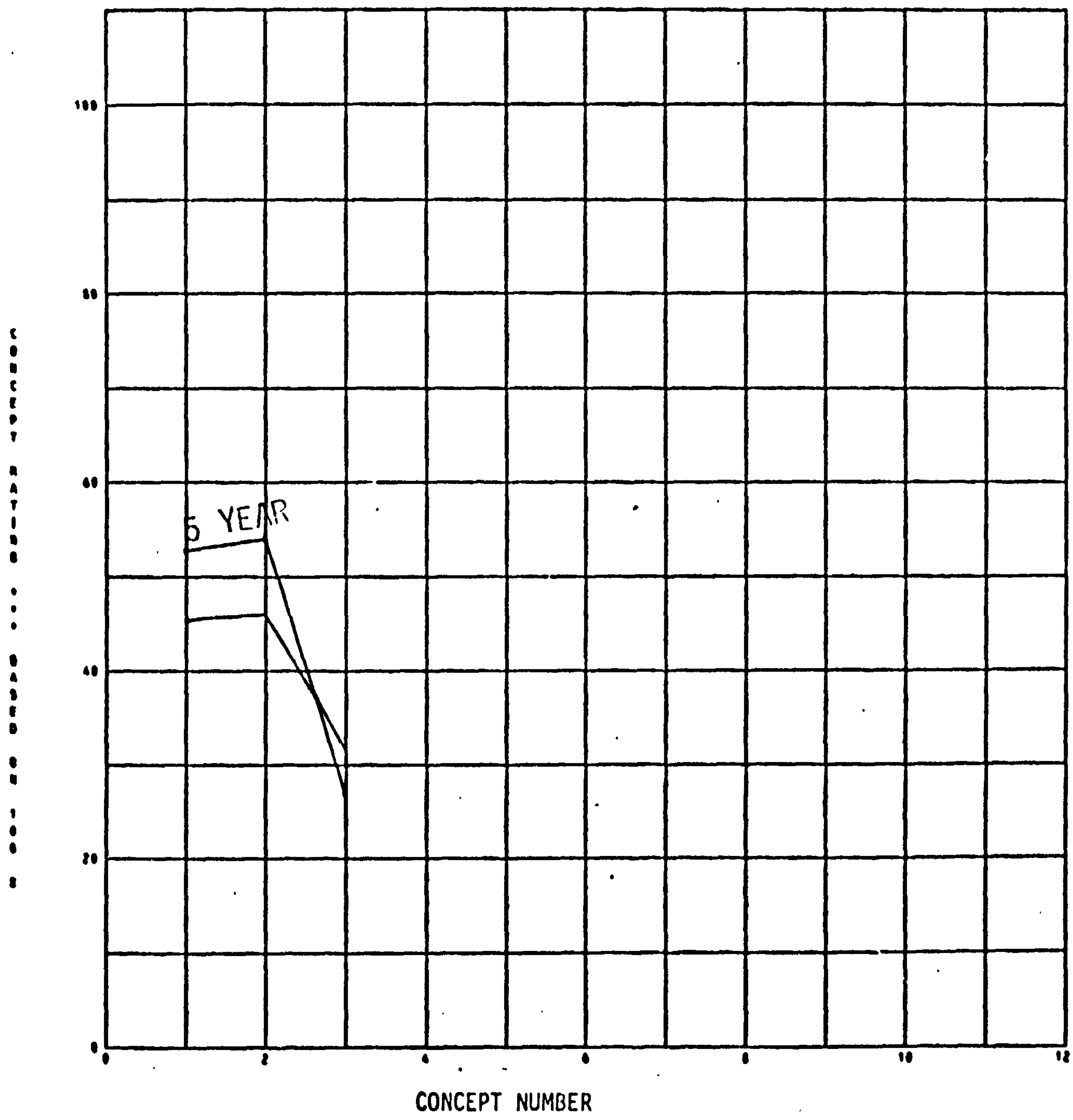
APPLIANCE CONCEPT NO.	CONCEPT NAME
1	MOIST HEAT
2	DRY HEAT
3	ETHYLENE OXIDE

(*)
1 - CABIN AIR (CIRCULATED), LITERS/SEC (FT^3/MIN)
2 - CABIN AIR (LOST) , KG/HR (LB/HR)
3 - OXYGEN (LOST) , KG/HR (LB/HR)
4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
5 - WATER (LOST) , KG/HR (LB/HR)
6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
7 - NITROGEN (USED) , KG/HR (LB/HR)
8 - FREON (CIRCULATED), KG/HR (LB/HR)
9 - WATER (PROCESSED) , KG/HR (LB/HR)

(**)AVAILABLE	(***)COST INDICATOR
(1) AVAILABLE	0-25%
(2) STATE OF THE ART	25-50%
(3) SOME DEVELOPMENT REQUIRED	50-75%
(4) EXTENSIVE DEV. REQUIRED	75-100%

APPLIANCE
CONCEPT
NO. CONCEPT NAME

1 - MOIST HEAT
2 - DRY HEAT
3 - ETHYLENE OXIDE



Autoclaves (Space Station) Concept Trade

NUMBER OF DAYS = 180.0 (.49 YEARS)
USES MOD SUBROUTINE 0
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - AUTOCLAVES (SPACE STATION)
(04/18/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	CONCEPT 2	CONCEPT 3
WEIGHT	24.000	526.80	15	13.45	14.32	.00
POWER	163.30	1079.2	15	.00	7.11	12.73
VOLUME	4.7800	9.0300	10	3.82	4.71	.00
THERMAL	48.768	184.06	15	4.02	.00	11.03
RELIAB-Y	.96707	.99916	5	4.87	3.79	.00
MAINTENC	.99999	1.00000	5	3.16	.00	3.17
SAFETY	1.0000	2.0000	5	2.50	2.50	.00
DEV COST	25.000	45.000	15	6.67	6.67	.00
TOTAL PT	.00000	85.000	85	38.49	39.08	26.93
RATING	.00000	100.00	100	45.28	45.98	31.68

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SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	45.28	45.98	31.68
WEIGHT	48.88	49.99	29.11
POWER	41.61	46.09	35.99
VOLUME	44.88	46.09	29.92
THERMAL	43.78	42.25	35.07
RELIAB-Y	46.77	46.83	30.77
MAINTENC	45.79	44.67	32.58
SAFETY	45.41	46.10	30.77
DEV COST	45.21	45.86	29.11

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	45.28	45.98	31.68
WEIGHT	40.98	41.20	39.74
POWER	49.66	45.85	26.53
VOLUME	45.72	45.91	33.66
THERMAL	47.07	50.43	27.63
RELIAB-T	43.70	45.08	32.69
MAINTENC	44.74	47.38	30.72
SAFETY	45.13	45.86	32.64
DEV COST	45.36	46.13	34.74

NUMBER OF DAYS = 1826.0 (5.00 YEARS)
USES MOD SUBROUTINE D
THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) .0540
THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) .1280
POWER PENALTY (LBS/WATT) TYPE 1 .7100
POWER PENALTY (LBS/WATT) TYPE 2 .5910

SELECTION MATRIX - - - - - AUTOCLAVES (SPACE STATION)
(04/18/75)

FACTOR	MIN VALUE	MAX VALUE	PTS	CONCEPT 1	2	3
WEIGHT	24.000	526.80	15	13.45	14.32	.00
POWER	163.30	1079.2	15	.00	7.11	12.73
VOLUME	4.7800	9.0300	10	3.82	4.71	.00
THERMAL	48.768	184.06	15	4.02	.00	11.03
RELIAB-Y	.71202	.99154	5	4.85	3.65	.00
MAINTENC	.99999	1.00000	5	3.16	.00	3.17
SAFETY	1.0000	2.0000	5	2.50	2.50	.00
DEV COST	25.000	45.000	15	6.67	6.67	.00
REC COST	.00000	476.25	15	15.00	15.00	.00
TOTAL PT	.00000	100.00	100	53.47	53.94	26.93
RATING	.00000	100.00	100	53.47	53.94	26.93

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY 50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	53.97	53.99	26.93
WEIGHT	55.99	56.84	25.05
POWER	49.74	53.48	33.97
VOLUME	52.74	53.61	25.64
THERMAL	51.60	50.18	30.18
RELIAB-Y	54.53	54.40	26.27
MAINTENC	53.70	52.63	27.82
SAFETY	53.38	53.85	26.27
DEV COST	52.84	53.28	25.05
REC COST	56.71	57.15	25.05

SENSITIVITY ANALYSIS

RATING FOR EACH CONCEPT AFTER INCREASING
SINGLE SELECTION PARAMETER WEIGHTING FACTOR BY -50 %
(BASED ON 100 % MAX POINTS)

	CONCEPT 1	2	3
NORMAL	53.97	53.99	26.93
WEIGHT	50.53	50.58	29.11
POWER	57.80	54.47	22.23
VOLUME	54.27	54.30	24.34
THERMAL	55.63	58.31	23.15
RELIAB-Y	52.35	53.45	27.62
MAINTENC	53.22	55.32	25.99
SAFETY	53.56	54.09	27.62
DEV COST	54.20	54.71	29.11
REC COST	49.69	50.21	29.11

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 5.1.1-AUTOCLAVES

COMPONENT TYPE / APPLIANCE TYPE	ACCUMULATOR	RELIEF VALVE	SOLENOID VALVE	PRESSURE REGULATOR	MANUAL VALVE	CHECK VALVE	HEATER	CONTROLLER TIMER	FILTER	MOTOR	BLOWER						NUMBER OF SAFETY CRITICAL ITEMS
NO.	4	25	3	11	23	22	17	19	9	1	13						
AUTOCLAVE, MOIST HEAT	3	1	2	1	1	1	1	1	-	-	-						1
AUTOCLAVE, DRY HEAT	1	-	1	-	-	-	1	1	1	1	1						1
AUTOCLAVE, ETHYLENE OXIDE	3	2	3	1	-	-	1	1	-	-	-						2

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Medical HABITABILITY FUNCTION Sterilization

APPLIANCE FUNCTION Autoclaves

APPLIANCE CONCEPT NO./TITLE 1/Moist Heat Sterilizer

INDEX NO. 5.1.1.1 REF. NO. 202

DESCRIPTION

The moist heat sterilization concept utilizes high temperature saturated steam as the agent for sterilization. The advantages of this system are its rapid heating, penetration, and moisture which facilitate the coagulation of proteins. This is the mechanism by which the organisms are destroyed. The units sterilization operating temperature range is 121 °C to 132°C (250°F - 270°F). The period of time used for this method of sterilization was assumed to be 15 minutes at 1551 mmHg (30 psia). The air within the autoclave was assumed to be exhausted overboard prior to each sterilization cycle to assure efficient sterilization. The volume of the chamber used for computing the vented gas was .0504 m^3 (1.78 ft^3). The water used per cycle was 0.072 kgms/use (0.158 lb/use) which is recondensed and recovered.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT I/MOIST. HEAT. STERILIZATION INDEX NUMBER 5.1.1.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(6)
HEATER	(202)	.25	1520	845	211	N/A		N/A
			1520 MAXIMUM		211 TOTAL	— MAXIMUM		— TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER			30	—
CHAMBER COOL DOWN			1023	—
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	309 (1053) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS/PENALTIES CALCULATIONS (CONTINUED)

CONCEPT 1/MOIST HEAT STERILIZATION INDEX NUMBER 5.1.1.1

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT^3)
AUTOCLAVE ASSY (202)	30	5.59
TOTAL	13.6 (30) KG (LBS)	.158 (5.59) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ ____ TOTAL WT/CYCLE (LB) Σ⑤ ____ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT. WT/CYCLE (LB) = ____ KG (LB)

TOTAL VOL MISSION = ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT. VOL/CYCLE (FT^3) = ____ M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
CABIN AIR	.132 (202)	N/A	N/A	.132

Σ① .132 Σ④ .132

TOTAL WT. MISSION = 1 CYCLE/DAY x 184 DAYS/MISSION x .132 TOTAL LOST/CYCLE (Σ④) = 24.3 (LB) + .132 (Σ①) = .69 (24.4) KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Medical HABITABILITY FUNCTION Sterilization

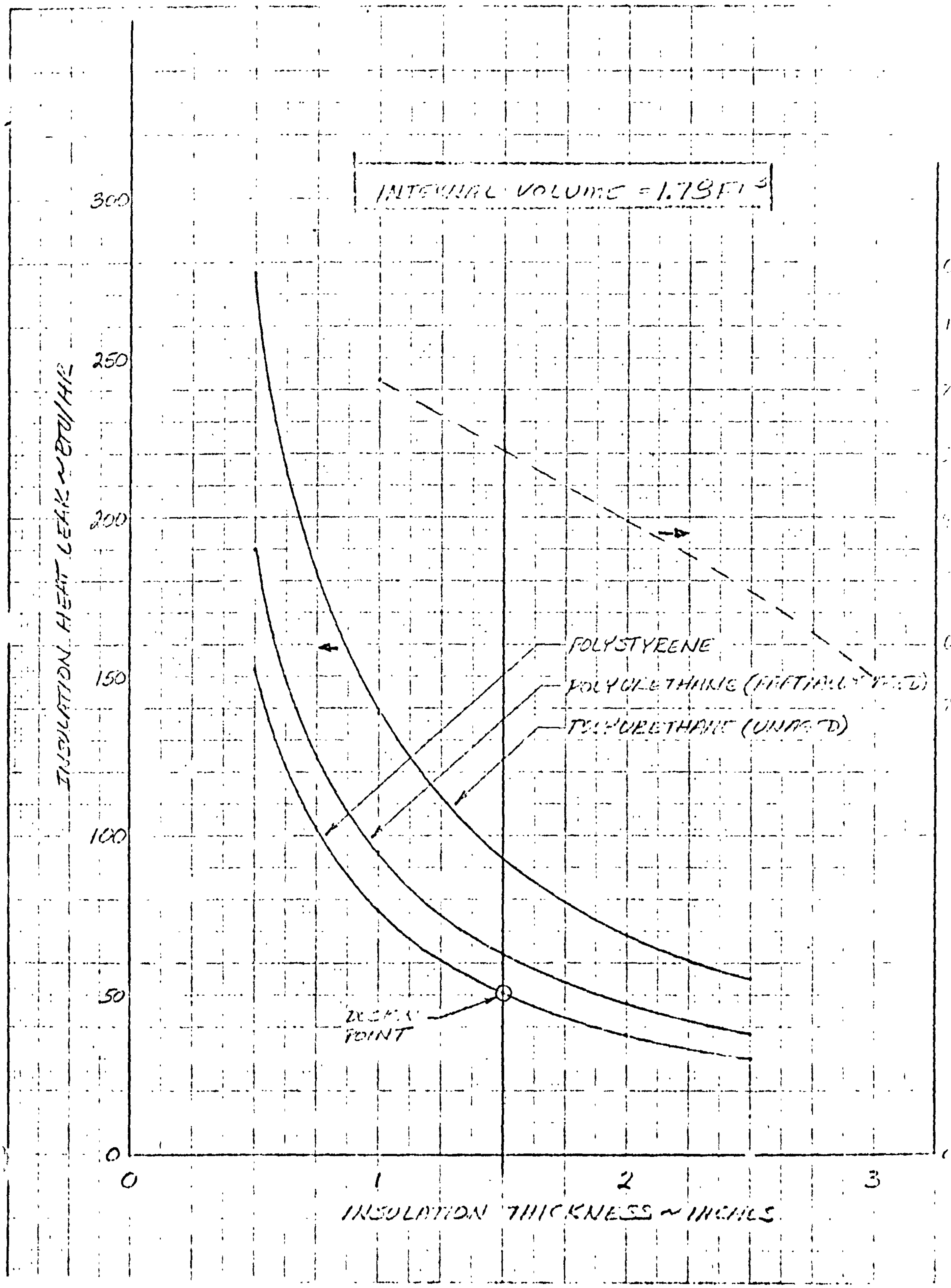
APPLIANCE FUNCTION Autoclaves

APPLIANCE CONCEPT NO./TITLE 2/Dry Heat Sterilization

INDEX NO. 5.1.1.2 REF. NO. 202

DESCRIPTION

The dry heat sterilization concept uses dry heat as the sterilization agent. This concept requires much higher temperatures and longer exposure times than Concept 1. The study assumed a 2 hour sterilization time period at 320°F. The dry heat destroys organisms by means of oxidation of their intercellular constituents. The unit will sterilize everything but aqueous materials because of its low vapor pressure. The dry heat chamber (1.78 ft^3) was assumed to be insulated with a .038 meter (1.5 inch) thick polystyrene foam (see attached figure). The heat leak calculated was based on this insulation system. In addition to the 2 hour sterilization period, a 20 minute warmup time was assumed.


INTERNAL VOLUME = 1.79 FT³
INSULATION HEAT LEAK ~ BTU/HR
300
250
200
150
100
50
0
POLYSTYRENE
POLYURETHANE
DESIGN POINT
0
1
2
3
INSULATION THICKNESS ~ INCHES

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 2/DRY HEAT STERILIZATION INDEX NUMBER 5.1.1.2

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	(3) AVERAGE (WATTS)	(4) DEMAND (WATT-HR/CYCLE) (1)X(3)	DC POWER (5) PEAK (WATTS)	(6) AVERAGE (WATTS)	(7) DEMAND (WATT-HR/CYCLE) (1)X(6)
HEATER	(202)	2.3	800	259	596	N/A		N/A
			800 MAXIMUM		596 TOTAL	— MAXIMUM		— TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
STERILIZATION PERIOD			50	—
COOLDOWN PERIOD			1388	—
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	421 (1438) WATT (BTU/HR)	WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT^3/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M^3/MISSION (FT^3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND FEASIBILITY CALCULATIONS (CONCLUDED)

CONCEPT 2/DRY HEAT STERILIZATION INDEX NUMBER 5.1.1.2

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
AUTOCLAVE ASSY	(202)	24	4.79
WITH INSULATION	(AL)		
TOTAL		10.9 (24) KG (LBS)	.14 (4.79) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT^3)	⑤ VOL/CYCLE ①x④ (FT^3)
N/A					

Σ③ TOTAL WT/CYCLE (LB) Σ⑤ TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION = CYCLES/DAY x DAYS/MISSION x TOT.WT/CYCLE (LB) = KG (LB)

TOTAL VOL MISSION = CYCLES/DAY x DAYS/MISSION x TOT.VOL/CYCLE (FT^3) = M^3 (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ① ③ (LB)
N/A				

Σ① Σ④

TOTAL WT. MISSION = CYCLE/DAY x DAYS/MISSION x TOTAL LOST/CYCLE (Σ ④) = (LB) + (Σ ①) = KG (LB)

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Medical HABITABILITY FUNCTION Sterilization

APPLIANCE FUNCTION Autoclaves

APPLIANCE CONCEPT NO./TITLE 3/Ethylene Oxide Sterilizer

INDEX NO. 5.1.1.3 REF. NO. 202, 292

DESCRIPTION

The ethylene oxide sterilizer concept uses a mixture of Freon 12 and ethylene oxide as a sterilant agent. The sterilizer was assumed to operate at 54 ^{o}C (130^{o}F) temperature, 1337 mmHg (22 psia) pressure, and at a relative humidity of 40%. The water used to raise the humidity and the air required evacuated prior to usage were assumed loss after each cycle. Since ethylene oxide is extremely flammable in air, mixtures of 88% Freon 12 and 12% ethylene oxide or 90% carbon dioxide and 10% ethylene oxide to circumvent this problem. The ethylene oxide sterilant mixtures are toxic and corrosive. A design using this concept would require careful interlocking of the chamber door to prevent accidental injury. The internal volume of the chamber was assumed to be .05 m^3 (1.78 ft^3) with approximately .003 pounds of water per charge for maintenance of relative humidity. The sterilant mixture is exhausted after the sterilization cycle is complete. The study assumed 20 hours were required for sterilization with a 5 minute warmup period. The cylinders used for the sterilant mixture were assumed to be aluminum.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT 3/ETHYLENE OXIDE STERILIZATION INDEX NUMBER 5.1.1.3

ELECTRICAL POWER REQUIREMENTS

COMPONENT	(REF)	(1) USE TIME CYCLE (HR)	AC POWER (2) PEAK (WATTS)	AC POWER (3) AVERAGE (WATTS)	AC POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	DC POWER (5) PEAK (WATTS)	DC POWER (6) AVERAGE (WATTS)	DC POWER (7) DEMAND (WATT HR/CYCLE) (1)x(6)
HEATER	(202)	20.1	230	171	3437	N/A		N/A
			230 MAXIMUM		3437 TOTAL	— MAXIMUM		— TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WARMUP PERIOD			50	—
STERILIZATION PERIOD			331	—
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	112 (381) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONTINUED)

CONCEPT 3/ETHYLENE OXIDE STERILIZATION INDEX NUMBER 5.1.1.3

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT	(REF)	WEIGHT (LBS)	VOLUME (FT^3)
AUTOCLAVE	(201)	24	5.59
WATER/STERILANT BOTTLE		90.8	3.44
TOTAL		52.07 (114.8) KG (LBS)	.256 (9.03) M^3 (FT^3)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB)	③ WT/CYCLE ①×② (LB)	④ VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT^3)	⑤ VOL/CYCLE ①×④ (FT^3)
WATER BOTTLE	.0054	1.256	.00683	.0127	.000069
STERILANT BOTTLE	.07609	6.4	.48697	.245	.018642

Σ③ .49380 TOTAL WT/CYCLE (LB) Σ⑤ .018711 TOTAL VOL/CYCLE (FT^3)

TOTAL WT. MISSION: 1 CYCLES/DAY × 184 DAYS/MISSION × .4938 TOT.WT/CYCLE (LB) = 41.21 KG (90.8) (LB)

TOTAL VOL MISSION: 1 CYCLES/DAY × 184 DAYS/MISSION × .018711 TOT.VOL/CYCLE (FT^3) = .0974 M^3 (3.44) (FT^3)

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT. USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT. RECOVERED/CYCLE ①×② (LB)	④ AMT. LOST/CYCLE ①-③ (LB)
WATER	.003 (202)	N/A	N/A	.003
STERILANT	2.092 (202)	N/A	N/A	2.092
CABIN AIR	.132 (202)	N/A	N/A	.132

Σ① 2.227 Σ④ 2.227

TOTAL WT. MISSION: 1 CYCLE/DAY × 184 DAYS/MISSION × 2.227 TOTAL LOST/CYCLE (Σ④) = 409.8 (LB) 2.227 (Σ①) = 186 (412) KG (LB)

HABITABILITY SUBSYSTEM 5.0 Medical

HABITABILITY FUNCTION 5.2 Physical Monitoring

APPLIANCE FUNCTION 5.2.1 Ergometers

NUMBER OF CONCEPTS CONSIDERED 1

ASSUMPTIONS

None

D2 [illegible]

SPACECRAFT Space Station

HABITABILITY SUBSYSTEM Medical HABITABILITY FUNCTION Physical Monitoring

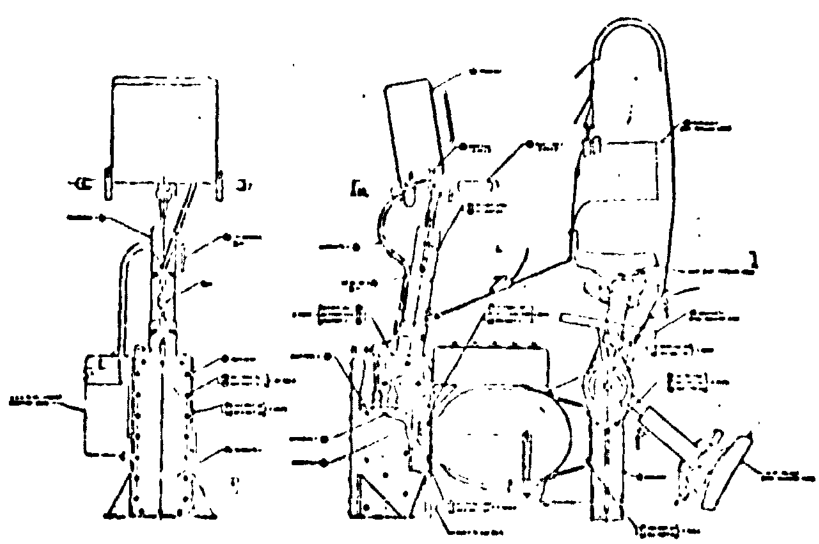
APPLIANCE FUNCTION Ergometer

APPLIANCE CONCEPT NO./TITLE Ergometer

INDEX NO. 5.2.1 REF. NO. 94, Skylab unit

DESCRIPTION

The ergometer is a bicycle-type, floor-mounted exercise machine with handlebars, bicycle seat, bicycle pedals, and a chest board. The ergometer is designed to allow the crew to exercise in a zero-g environment, using either his hands or his feet to drive the ergometer. The ergometer is capable of automatically programing heart rate (100 to 200 beats per minute) which is accomplished by a feedback loop control in which the workload varies automatically to produce desired heart rates. The exercise is accomplished by manually pedaling which drives a DC torque motor. The work is released to the environment as heat. The rate of power application in the automatic mode shall be adjustable from 25 to 100 watts per minute. The manual mode workload range is 25 to 300 watts.



APPLIANCE CONCEPT REQUIREMENTS / SYSTEM PROCEDURES COMPUTATIONS (CONTINUED)

CONCEPT *ERGOMETER* INDEX NUMBER *5.2.1.*

FIXED WEIGHT/VOLUME REQUIREMENTS

COMPONENT (REF)	WEIGHT (LBS)	VOLUME (FT³)
ERGOMETER INCLUDING ELECTRONICS	*165*	*37.5*
TOTAL	*74.84 (165)* KG (LBS)	*1.06 (37.5)* M³ (FT³)

SOLID EXPENDABLE WT/VOL REQUIREMENTS

TYPE	① UNITS/CYCLE (REF)	② WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB)	③ WT/CYCLE ①x② (LB)	④ VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³)	⑤ VOL/CYCLE ①x④ (FT³)
N/A					

Σ③ TOTAL WT/CYCLE (LB) Σ⑤ TOTAL VOL/CYCLE (FT³)

TOTAL WT. MISSION ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.WT/CYCLE (LB) = [____ KG (LB)]

TOTAL VOL MISSION ____ CYCLES/DAY x ____ DAYS/MISSION x ____ TOT.VOL/CYCLE (FT³) = [____ M³ (FT³)]

GAS/LIQUID EXPENDABLES REQUIREMENTS

TYPE	① AMT.USED/CYCLE (REF) (LB)	② RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ①x② (LB)	④ AMT LOST/CYCLE ①-③ (LB)
N/A				

Σ① ____ Σ④ ____

TOTAL WT. MISSION = ____ CYCLE/DAY x ____ DAYS/MISSION x TOTAL LOST/CYCLE (Σ④) = ____ (LB) + ____ (Σ①) = [____ KG (LB)]

D2-11[illegible]

APPLIANCE CONCEPT REQUIREMENTS [illegible] CALCULATIONS

CONCEPT ERGOMETER INDEX NUMBER 5.2.1

ELECTRICAL POWER REQUIREMENTS

COMPONENT (REF)	(1) USE TIME CYCLE (HR)	A.C. POWER (2) PEAK (WATTS)	A.C. POWER (3) AVERAGE (WATTS)	A.C. POWER (4) DEMAND (WATT HR/CYCLE) (1)x(3)	D.C. POWER (5) PEAK (WATTS)	D.C. POWER (6) AVERAGE (WATTS)	D.C. POWER (7) DEMAND (WATT HR/CYCLE) (1)x(7)
ELECTRONICS		15	15				
		15 MAXIMUM		TOTAL	MAXIMUM		TOTAL

THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
ALTERNATOR POWER DISSIPATED TO CABIN	—	683	683	—
TOTAL	WATT (BTU/HR)	WATT (BTU/HR)	200 (683) WATT (BTU/HR)	— WATT (BTU/HR)

OPERATIONAL PENALTIES

SOURCE	THERMAL HEAT LEAK (BTU/HR/CYCLE)	THERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
N/A					
TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)